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## *EDITORIALS*

## GRADUATE TRAINING IN ORAL SURGERY

The surgical proficiency of today is the result of the decisive planning of yesterday, by means of which the more or less haphazard apprenticeship system of training has been rapidly supplanted by scientifically set up well-rounded programs of graduate training in general surgery and its many specialties. The efficiency of such standardized programs has been amply demonstrated by war experience in which the application of sound surgical principles based on adequate training saved more than 90 per cent of the wounded who reached Army hospitals. The survival rate in maxillofacial wounds was even better. Surgeons may well be proud of such a record of their accomplishments. An excellent résumé of the progress of graduate training in surgery and its specialties, the formation of the specialty boards and the development of the American College of Surgeons program is presented by Maj. Gen. Charles R. Reynolds.[1] This can be read with profit by those concerned with graduate training in oral surgery. The objectives of the College of Surgeons program are to elevate the standards of surgical care and to assist in the organization of hospital graduate training not only to assure adequate clinical and operative experience but also to provide facilities for study of the basic medical sciences as applied to surgery. It is agreed that these should include surgical anatomy, physiology, biochemistry, pathology, bacteriology and roentgenology, taught by the applicatory system as far as is possible.[2] The setting up of arrangements for such basic training

1. Reynolds, C. R.: Graduate Training in Surgery and Surgical Specialties. Bull. Am. Coll. Surgeons 30:95-102, June 1945.

2. Miller, G. H.: Basic Medical Sciences in Graduate Training in Surgery. Bull. Am. Coll. Surgeons 30:103-109, June 1945.



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required considerable planning and effort, particularly in the hospitals that were not associated with medical schools with organized departments in the respective basic sciences. Many such hospitals now provide fine training in these subjects and have accordingly been approved for graduate training, for it was obvious that hospitals associated with universities were incapable of training a sufficient number of general surgeons and specialists to meet the needs of the American public.

It is of interest to note that no mention is made of oral surgery in the numerous publications of the College of Surgeons on the subject of graduate training. This is to be expected in that the progress in this specialty and its continued development have been largely due to active interest in this subject on the part of members of dental school faculties and other members of the dental profession. It is a notable fact that the increasing complexity of the modern undergraduate course of medicine has largely eliminated consideration of the oral cavity and its diseases and surgery from the medical curriculum, and the medical intern year is usually devoid of any worth while experience in this field.

There has been a growing appreciation of not only the desirability, but also the necessity for hospitalization of patients requiring anything but minor surgical procedures. The College of Surgeons is committed to the requirement that surgeons shall be adequately trained and should not operate in unaccustomed fields. Already hospital staffs are being reorganized and reclassified on the basis of competency. Adequate training and certification by the national boards of general surgery and the surgical specialties will probably become the qualification for appointment to the surgical staffs of hospitals, and operating room privileges will be denied those not so trained and accredited. The raising of standards is inevitable, for such is progress.

It is obvious that the time is not far distant when oral surgeons without adequate training will be denied operating room privileges of the hospitals in the larger cities. It stands to reason that the oral surgeons must have the same background of graduate training in the basic sciences and a clinical training in oral surgery comparable in every way with the approved graduate training in a specialty of surgery such as otolaryngology, in order to render service equivalent to that rendered by surgical specialists in other fields. Nothing less is acceptable, for there is no greater need for better surgical care than in oral surgery. It is generally considered that three years of graduate training is the minimum time necessary for the training of a surgeon in any of the specialties of surgery. Some, such as plastic surgery, now require at least two years' training in general surgery before three or more additional years of training in the special field of plastic surgery is undertaken.

No time should be lost in the organization of suitable graduate training programs in oral surgery, since an increasing number of letters is being

received from dental officers indicating their desire to spend several years of intensive training in oral surgery before entering private practice. The American College of Surgeons has done pioneer work in the graduate training field during the six years that its formal program has been in operation. From among the 230 hospitals approved for graduate training in surgery, which also provide applied basic science facilities, many with adequate clinical material and opportunities in oral surgery may be selected for the training of the oral surgeon.

Acceptable programs for graduate training in oral surgery may show considerable variation in their plan of operation.[3]

1. Those under graduate school auspices will make possible the conferring of a graduate degree at the conclusion of the training. It is desirable to include the minimum applied basic science training in the first year, leaving sufficient time for study of the fundamentals of clinical oral surgery and attendance at oral surgery clinics, with some assisting at operations in order to orient the graduate student. The remaining years of training should be devoted almost exclusively to clinical and operative oral surgery, although certain elective courses in subjects of interest to surgery may well be taken.

2. The plan outlined in section one implies the completion of graduate training in one institution. The number of graduate students at a given institution is therefore limited by the amount of clinical work and the opportunities available for a complete and adequate training in oral surgery. It is obvious that a number of universities can organize an effective program in the applied basic sciences and the fundamentals of oral surgery with clinical work, and could enroll a much larger number of graduate students for their first basic year than could be accommodated for the subsequent clinical and operative training. These men may then go to larger centers for their subsequent training under the guidance of oral surgeons in these centers. This is essentially the plan of the graduate school of the University of Pennsylvania, which has proved eminently successful. At the completion of the third year of training, the graduate students return to the University of Pennsylvania for examination and the conferring of their graduate degree. The graduate degree is of course desirable, but it is no more essential in oral surgery than it is in the program of graduate training in surgery and its various specialties. A well-rounded clinical experience, sound surgical judgment and proficiency are the prime objectives of the program.

3. Certain hospitals and clinics not associated with universities present great opportunities for graduate training on account of the great number of patients presenting oral surgical conditions. Most of these hospitals are approved for graduate training in surgery. In these, the organization of a program of training in oral surgery should be undertaken. Much of the

3. Ferguson, P. S.: Three Specimen Programs in Graduate Training in Surgery. Bull. Am. Coll. Surgeons 30:110-121, June 1945.

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training may be taken with the graduate students in surgery or the specialties. Most hospital pathologists are greatly interested in oral surgical pathology, but have not organized their material for concentrated study by the graduate student. The cooperative effort of the oral surgeon and full-time pathologist and clinical laboratory service can result in an effective set-up for graduate training in the applied basic sciences. A graduate training program presents a great opportunity and a responsibility to the oral surgeon in charge of the work in the respective hospitals. That he will meet this opportunity for service to the student and the public is assured; for the concepts of the guild of surgery for centuries have conformed to the Hippocratic Oath that "by precept, lecture and every other mode of instruction, I will impart a knowledge of the Art."

PROPOSED MINIMUM STANDARDS FOR GRADUATE TRAINING IN ORAL SURGERY

1. *Duration and Objective.*—Graduate training in oral surgery shall be of sufficient duration and educational content to enable the young oral surgeon, on completion of such training, to begin the practice of oral surgery in a scientific manner. An acceptable program requires a minimum of two and preferably three years.

2. *Organization and Supervision.*—(*a*) The oral surgery staff shall be organized and made responsible for the graduate training program and for the personal supervision and direction of the work of the graduate student. (*b*) Records should be kept of the activities of the graduate students as may be necessary to assure an equitable distribution of work and, together with some form of examination, provide a basis upon which the plan of graduate training can be evaluated.

3. *Basic Medical Sciences.*—The hospital or institution shall maintain a clinical laboratory, an x-ray department and other adjunct diagnostic and therapeutic facilities essential to diagnosis and treatment. These facilities shall be under the continuous supervision of accredited heads of departments and have qualified technical assistants. The graduate student shall be required to devote adequate time to the study of gross and microscopic pathology, with special emphasis on oral and regional pathology, and to participate in necropsies. He should acquire a degree of practical knowledge of clinical radiology of the head and neck and should pursue anatomic studies pertinent to oral surgery by dissection on the cadaver. Participation in clinical or experimental research is advisable, and definite time should be devoted to the study of other basic medical sciences.

4. *Clinical Material.*—There shall be an active oral surgical service and an organized outpatient department with systematic follow-up clinics and an adequate number of patients to give the graduate student opportunity for training and experience in the diagnosis, treatment and study of end-results of a variety of oral surgical conditions. Operative experience, under

supervision, sufficient to obtain a degree of technical efficiency shall be provided.

5. *Organized Study.*—There shall be provided a medical and dental library containing a wide range of standard textbooks, current journals and periodicals with a librarian in charge. A definite program of reading of scientific literature under guidance of the oral surgical staff shall be required. The graduate student should participate in staff conferences, departmental conferences and clinicopathologic conferences, and, if possible, be made responsible for some teaching activity.[4]

### CERTIFICATION BOARDS

There are fifteen approved examining boards in the medical and surgical specialties the functions of which are to establish the minimum qualifications, training and competence deemed necessary for certification in the respective specialty and to award certificates to those who voluntarily apply and satisfy the board of their qualifications. More than 24,000 certificates have been awarded to specialists in medicine and surgery and there are indications that 12,000 or more medical officers from the services will seek specialty certification in the near future.

The boards make no attempt to control the practice of a specialty by efforts to promote any license or legal regulations whatsoever.

It is apparent that, in conformity with the general progress and trends of the practice of general surgery and the specialties of surgery, certification of specialists in oral surgery will in the future be required for staff appointments in all important hospitals and for teaching positions in universities. Such certification is assuming greater importance in industrial surgery, and in compensation and insurance relationships and may be anticipated in prospective prepayment health insurance programs. Certification is required of applicants for membership in a number of local and national special societies.

C. W. WALDRON

## MAXILLOFACIAL WOUNDS

The high standard of surgical care in World War II and the excellent results thereby secured have been largely due to the broad policies and guiding principles presented from time to time by the professional division of the Surgeon General's office. The accumulated data of extensive experience have confirmed the soundness of certain principles and have formed the basis of modification of others. This holds true for maxillofacial surgery, which has been covered by teams consisting of plastic and dental oral surgeons. This efficient and cooperative teamwork should not terminate with

4. Bibliography: Graduate Training in Surgery. Books and Monographs. Journal References. Bull. Am. Coll. Surgeons 30:122-131, June 1945.

war activities. It can be continued and developed in the care of civilian and industrial accidents, to the great advantage of the patients concerned. By and large, civilian patients with extensive lacerated facial wounds, associated with compound fractures, have not had such efficient and skilful care as that of the maxillofacial units of the services, which has been progressively modified and improved.

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*Maxillofacial Wounds.*—The hazards to life in initial operative management are often greater than those associated with the original wound. There should be no hesitancy in performing tracheotomy when there are indications that obstruction of the airway should be relieved by that method. On the other hand, tracheotomy is difficult in a long evacuation line, frequently requiring a personal attendant. The choice of the anesthetic agent, as well as the technics of its administration, requires expert judgment and skill.

The procedures of initial surgery are based on the following principles, in order of importance:

1. Reduction and fixation of fractures of the bony foundation structures. Temporary measures may suffice for transportation purposes, with the intent to employ more elaborate and precise splinting at a rear installation.

2. Isolation of the buccal cavity from the wounds of the bone and superficial soft parts by suture of the mucous membrane.

3. Primary closure of the muscles and skin, with provision for adequate drainage in anticipation of infection. If the defect is such that primary closure is not possible and the wound enters the buccal cavity, the edges of the skin and mucous membrane should be carefully approximated.

4. Application of moist pressure dressings.

The management of the soft part wound by primary suture, with or without plastic repair, must not tempt the forward surgeon to hold a patient for supervision of healing, with the result that precise and firm splinting of the bony parts is postponed.

Those cases of severely comminuted fracture or loss of bony substance, with major soft tissue defects, require evacuation to the zone of the interior as soon as the patient can care for himself and after the dangers of infection have passed.—*Bull. U. S. M. Dept.*, September 1945.

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## DELAY IN PUBLISHING

It is regretted that this issue of the JOURNAL OF ORAL SURGERY has been unavoidably delayed. The regular schedule of publication will be resumed as soon as possible.

# CONTROL OF BONE FRAGMENTS IN MAXILLOFACIAL SURGERY

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The basic treatment for fracture, rest and immobilization, cannot be ascribed entirely to the ingenuity of civilized man. The dog or horse will immobilize a fractured bone as nearly as possible. According to civilized man, the animal strives only to relieve pain. Man's purpose in fracture treatment is to place and maintain the bone or bone fragment in as nearly normal position and condition as possible. It then becomes our aim to maintain that position, and, to accomplish this, we must have immobilization. The reasons for reduction and immobilization of fractures of the facial bones are many. None of these, in my opinion, is more important than the others. They should all be considered together:

1. To establish normal function of an organ or a part which has been checked or impaired directly or indirectly as a result of bone fracture or dislocation. For example, the fracture and dislocation of the malar bone inwardly may produce ocular disturbances, abnormal muscular activity and double vision.

2. To prevent spasm of muscles, or lack of muscle tone that would produce asymmetry of the face as a result of unequal muscle pull.

3. To prevent asymmetry of the bony wall itself; for example, in compression fractures of the orbital ridges. Cartilage transplants will improve the appearance, but will not assure normal bone position.

4. To conserve all viable bone possible. Complete early immobilization saves many bone fragments that will not live if this is not accomplished.

5. To promote tissue healing in the area of bone fracture by rest, so that there may be healing between the bone ends themselves and actual tissue repair and building as soon as possible.

6. To induce the building of soft tissue between bone fragments, when there has been considerable loss of bone. This built-in soft tissue is a great aid to subsequent bone grafting in the mandible, its presence, when it is free from latent infection, preventing the operator from accidentally opening into the mouth cavity. It also prevents infection, which often follows bone grafting when the oral cavity is involved.

7. To minimize pain and resulting trauma to the surrounding tissues and avoid the possible introduction of infection either intra-orally or extra-orally, with resulting cellulitis and production of bacteremia.

Reduction and immobilization should be attained by means of the most conservative methods possible for favorable results. The condition of the

*Captain (DC) AUS.

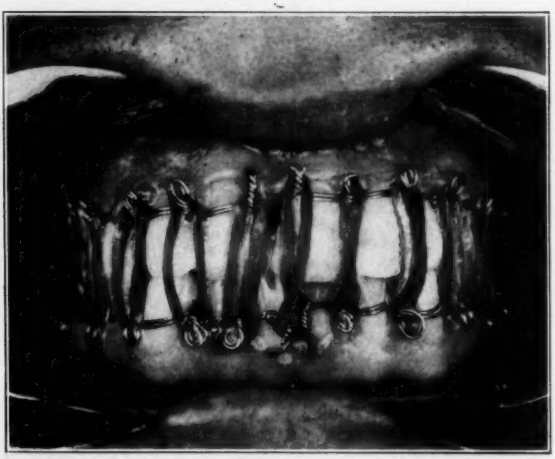

Fig. 1.—Interdental wiring with intermaxillary elastic traction; double wiring applied because of ease of installation and added loop rigidity.

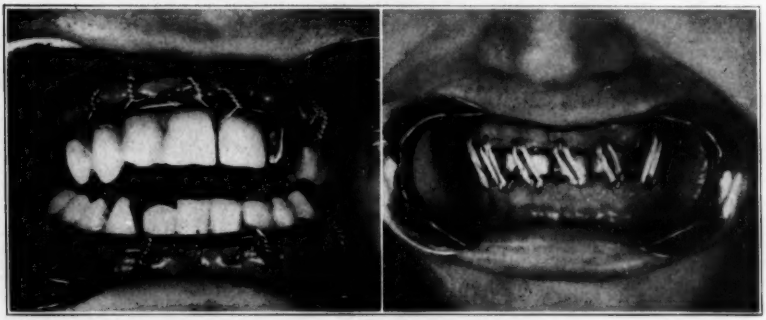

Fig. 2.—Left: Arch wire stabilization using interdental wires in which rubber ligature intermaxillary traction is to be employed. Right: Arch bar with soldered lugs and elastic stabilization.

patient, the position of the fragments and the location of the fracture are all significant. Multiple fractures should be considered jointly rather than singly, for often stabilization of one part will cause dislocation of another. The final outcome should always be visualized. The means employed may vary with the experience of the dental surgeon. There are many methods of fracture reduction and fixation, some having better results in the hands of certain men than in the hands of others. Various methods may be combined and employed together for good end-results. To say one method can be universally used is idle talk. There are specific indications for most

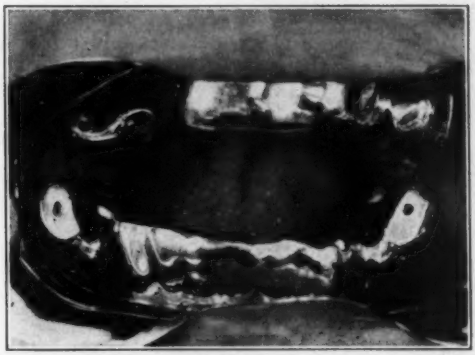

Fig. 3.—Cast silver interlocking flange splint with pins; used in stabilization of mandible previous to bone graft in symphysis area. The cast bar bridges the area of bone loss.

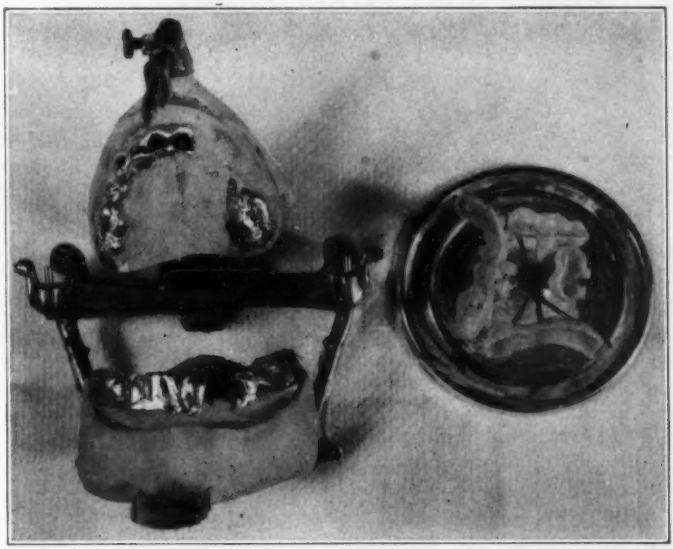

Fig. 4.—Casts and wax patterns for construction of cast metal silver interlocking fixation splint. Tinfoil is adapted over the cast to relieve the undercuts and take care of shrinkage of the silver.

fracture reduction and stabilization technics, although some of these have definite limitations and should be used only when they are the sole means of assuring a good end-result.

The head bandage has a definite place in first aid or emergency treatment. It affords stabilization to a degree, and gives the patient a sense of security

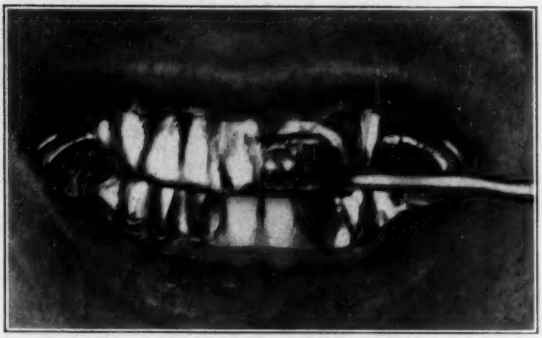

Fig. 5.—Interlocking cast silver flange splint with pin fixation; external bar fixation for controlling posterior fragment.

Fig. 6.—Cast silver interlocking splint with pin-lock stabilization for bone graft in symphysis area. The addition of brass plates to mandibular splints is now recommended in splints of this type, to provide for subsequent attachment of a bar across the incisor region.

and a feeling that something is being done, although it is to be replaced by other treatment later. The use of head bandages for the purpose of definitive fragment control is to be discouraged. If there is any displacement, the use of tension bandages generally tends to exaggerate this displacement. The use of chin cups in connection with head bandages seldom has satisfactory results. Outside of first aid treatment and emergency measures, they should be employed only for supplementary treatment.

The use of wire interdentally around the necks of the teeth is perhaps the oldest of methods for jaw fracture fixation. It is one that has survived the test of time since ancient Greece. Many methods of wire stabilization have

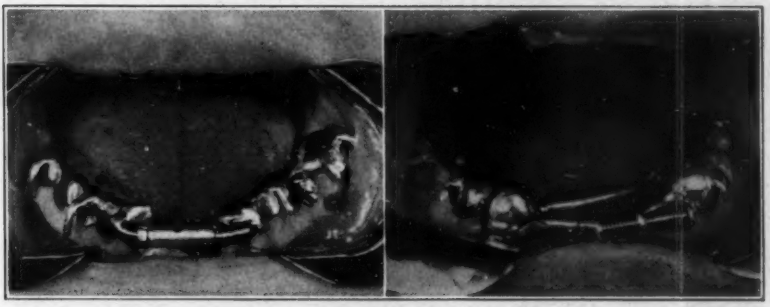

Fig. 7.—Left: Cast silver mandibular splint with turn buckle in lower incisor area to aline fragments where there is collapse owing to bone loss in symphysis area; screw extension to single left molar casting to maintain distal fragment. Right: Adjustable screw attachment used to control inward rotation of fragments; cast silver splint.

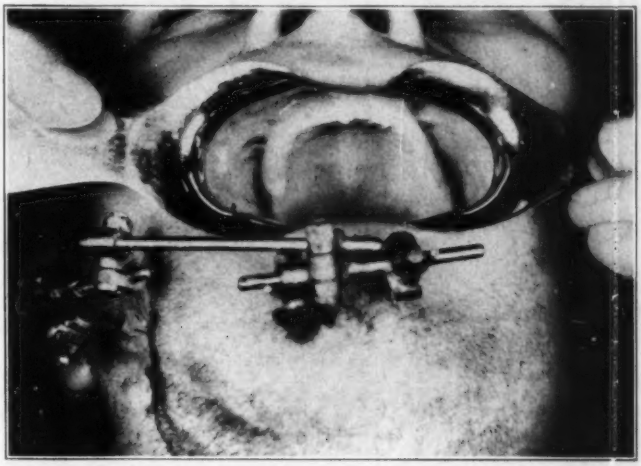

Fig. 8.—Extra-oral pin fixation, indicated where no other form of fixation can be accomplished.

been offered, each with its own merits and its place. The Gilmer type is one of the oldest of present-day wiring technics. From it have evolved most present-day wire fixation methods, in which the upper jaw or the lower jaw is stabilized by its opponent. The Eby-Ivy[1] type of fixation, the Risdon type and the Stout continuous wire loop all employ the same principles, the purpose of which is to produce lugs or loops by which intermaxillary immobilization may be accomplished, as well as direct fragment fixation. The

1. Ivy, R. H.: Repair of Bony and Contour Deformities of Face. Am. J. Orthodontics 30:78, January 1944.

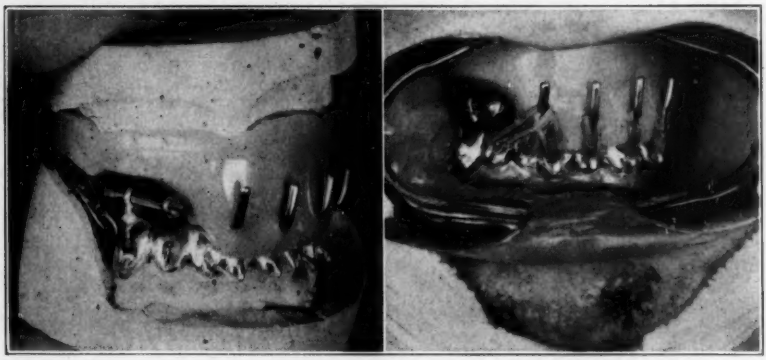

Fig. 9.—Left: Cast silver mandibular splint with adjustable conformed disk to hold ramus in position in case of fracture of right mandible, angle and body, with loss of substance. The lower teeth lock into the acrylic upper appliance. Right: Intermaxillary elastic stabilization.

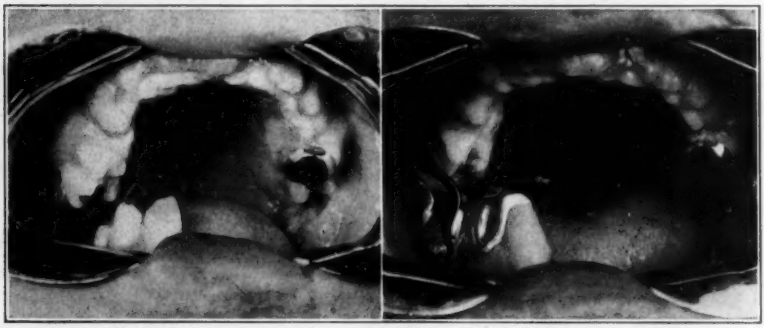

Fig. 10.—Left: Lingual rotation of right fragment after loss in left angle and body. Right: Cast silver flange splint for correction of right fragment; showing loss in left body and angle.

Stout continuous wire offers a maximum number of stabilization and traction loops and eliminates sharp projecting lugs on the buccal surfaces of the teeth.

The advantages of using interdental wire over the interdental splint are: almost immediate reduction; elimination of impression taking, time consuming laboratory procedures and the excessive time elapsing between the time of injury and fracture stabilization; observation of the condition of the teeth at all times, and the fact that the opposing teeth are in direct occlusion with their opponents.

The type of wiring used depends on the number, position and stability of the teeth in their respective arches and on the location of the fracture.

Fig. 11.—Posterior fragment control by use of plaster headcap and adjustable wire through angle.

Any tooth that is involved in the line of fracture should not be included in the wiring of the jaw unless existing conditions make wiring of the tooth in the actual fracture absolutely essential. The gage of wire employed in interdental fixation should not exceed 22, and preferably it should be 24 or 25, since the use of unduly heavy wire, besides its being difficult to handle and more painful to the patient on installation, causes a definite pressure atrophy of alveolar bone, irritates unnecessarily the interdental papillae and creates a definite gingivitis. If added stability is desired, I prefer the use of double wiring, as double wires of small gage approach in nature a band and do not act as wedges. The double wire also increases loop stability.

The arch bar attached by interdental wire loops or by tooth bands may be used for stabilization. It is constructed with or without lugs. It is easier to install in case of trismus than the conventional types of interdental wiring. Installation consumes less time and is less painful to the patient. If many teeth are missing, arches may be conformed with lugs in order to attain a greater number of fixation points than there are teeth in the arch. Another advantage of these arch bars is that they are rigid enough to withstand considerable traction and distribute an applied force in any

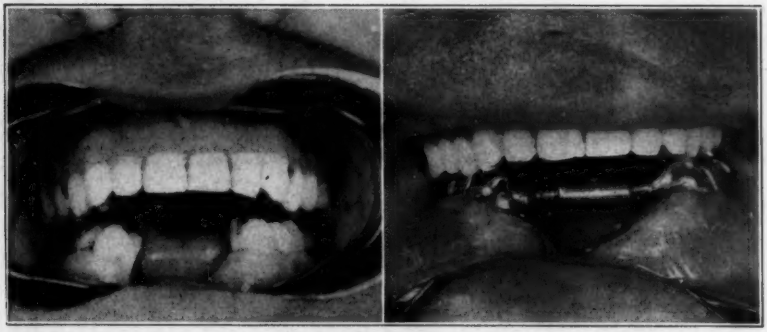

Fig. 12.—Left: Fracture of mandibular symphysis area with loss of substance and collapse of fragments. Right: Cast silver cap splint with turn buckle to correct and maintain fragments.

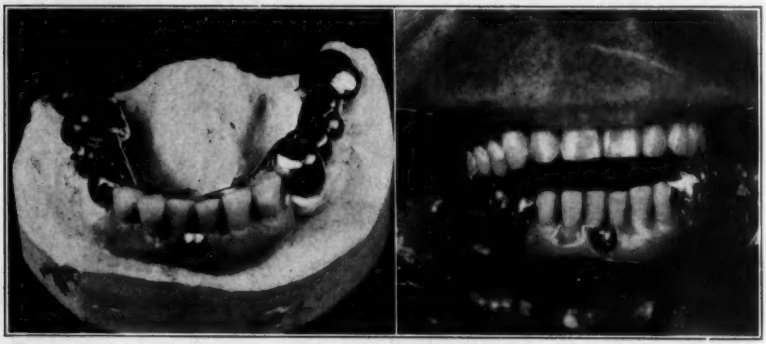

Fig. 13.—Left: Cast silver splint applied after removal of interlocking splint for added stabilization. The six anterior teeth are of acrylic and are mounted in an acrylic saddle and attached by screws to the connecting bar. Right: Cast silver splint inserted in mouth.

direction over a greater area of the dental arch than would be possible with interdental wiring, the lugs themselves offering more rigidity than the ordinary wire loop. The chief disadvantage of arch wires is that their position often produces a pressure gingivitis, since it is hard to maintain them rigidly, in their original position, unless the connecting wires are in the beginning placed upon the area of greatest constriction of the tooth.

Rubber ligature fixation is the most universally indicated and the most adaptable type of fixation; that is, where it actually accomplishes immobilization. It is also the most universally abused type of fixation. The purposes of rubber fixation may vary. It may be used to accomplish reduction through traction, as well as stabilization. As soon as it has accomplished reduction, its only purpose is stabilization, and it should afford

just that. There should be no movement except for reduction in the early stages since movement may permit salivary contamination of the line of fracture. There should be no opportunity for production of fibrous tissues between the bone fragments and none for foreign body interference. Many fibrous unions following rubber ligature fixation can be attributed to instability, due to the ability of the patient to counteract such traction and produce movement enough to break down the primary blood clot between these fragments. Rubber ligatures in all cases of early fracture fixation should be so strong that the patient may not counteract traction by voluntary muscular action. In the later stages of fracture treatment, reduction of the amount of rubber traction is favorable to union and a desired result, but only at this time.

Fig. 14.—Cast silver alloy single unit splint employed in simple mandibular fracture. Intermaxillary fixation may be employed by using the cast tabs on the splint.

Intermaxillary wiring still holds a place in jaw stabilization, a place that is deserved. Although it is considered hazardous for motor, ship or air transportation, because of releasing complications, it has definite indications, since there are conditions in which it, and only it, can be used as a means of assuring desired results. When intermaxillary wiring is used, all necessary precautions should be taken, and provision should be made so that the patient, if not under supervision, can himself release or remove the wire at a moment's notice, if the need arises.

Insertion of the ordinary brass cotter key into the loops of interdental wiring of the opposing jaws and lacing of the key within these loops has proved satisfactory for intermaxillary stabilization, along with various other appliances such as hooks and eyes. This method offers, as well as stability, the advantage of immediate release of the upper and lower jaw. The cotter key may be used in conjunction with wire or rubber ligature fixation.

Displacement of bone fragments when the mandible or maxilla is edentulous may be reduced through alveolar wiring of the individual fragments, by insertion of wire through the alveolus of one fragment to another and by attachment directly to adjacent stable bone, or to a bridging splint or appliance. Direct insertion of wire through the alveolar process of the maxillae to stabilize an upper denture or splint in conjunction with circumferential wiring of the mandible over a denture or splint generally has good results in edentulous cases. This method may be used advantageously to reduce or immobilize bilateral fractures of the angle or condyles. The

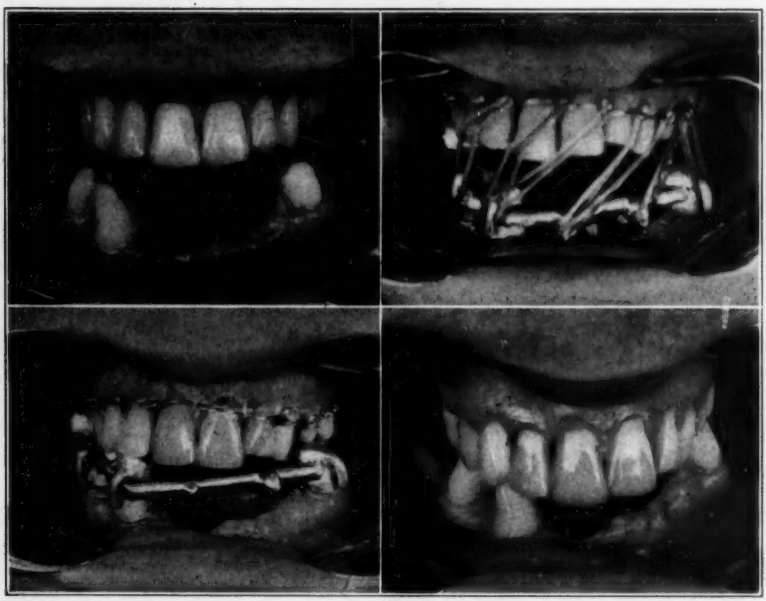

Fig. 15.—Treatment for bilateral condylar fracture with open bite. The upper right third molar was tilted lingually, but this condition was compensated by incorporation of a lingual table in the casting on the right lower second molar. Elastic intermaxillary traction was employed.

insertion of alveolar wire loops in the edentulous maxillae and circumferential wiring of the edentulous mandible, with direct connection between the two, may be used as an emergency measure in the stabilization of edentulous jaws with fracture of the angles of the mandible, since in these cases early treatment is imperative, and may be the only alternative. Because of the high percentage of nonunion in such cases, this treatment, although radical, is often advisable in emergencies. When this

type of fixation is used, infection may be expected, but it is generally of little consequence, usually being only superficial.

Intra-osseous, intra-oral and extra-oral wiring are indicated in fracture of facial bones when it is impossible to maintain these fragments by other methods. This type of wiring is contraindicated in the presence of infection. It is especially applicable in fracture of the orbital ridges, mandible, ramus and angle and of the malar bone. Intra-osseous wiring of fragments usually should be supplemented by added immobilization of some kind whatever it may be, for alone it does not give sufficient support. These intra-osseous

Fig. 16.—Old horizontal fracture of maxillae with malpositioning. A headcap with rod extension was connected with the interdental maxillary silver cast splint by strong elastic traction forward. Interdental mandibular wiring with elastic bands was employed for traction downward.

wires may be removed or may remain permanently. Intra-osseous wiring does not require elaborate specialized instrumentation and assures immediate reduction and fixation.

The cemented cast metal cap splint has been used extensively, especially in immobilization of complicated fractures. It is both adaptable and flexible. Its use involves more time and effort and additional equipment, but the time and material spent in its construction and planning are worth while. It may be used solely as a stabilizer, or in combination as a reducing appli-

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ance and space maintainer. Numerous connections and appliances may be incorporated in it to produce definite movement of fragments to any extent or angle. These extra appliances can be removed, readjusted or changed through the use of universal male and female threaded attachments.

This type of splint lends itself to the treatment of a great many types of fractures. It may be altered by both intra-oral and extra-oral extensions. Extra-oral extensions may be employed by attachment to this type of splint without the use of a headcap. The cast splint is especially indicated over long periods of time and in case the patient may not be under continuous supervision or conditions make it necessary for extensive periods of time between treatment. Good oral hygiene may be maintained with little

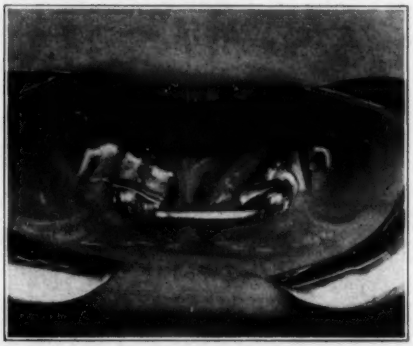

Fig. 17.—Cast silver cap splint for stabilizing symphysis fracture; bar attachment fixed by male and female screw attachments. Stent support for a skin graft may be substituted to relieve obliterated labio-alveolar sulcus.

difficulty with these appliances. To summarize the indications for the cast metal cap splint: It is especially indicated in the following cases:

1. When the teeth are few and rigid extensions are necessary to correct and maintain tooth and bone fragment position.

2. As mentioned previously, in extensive loss of bony substance, when it may be used to maintain a definite space for a later osseous graft.

3. When the crowns of teeth are broken down in such a way that wiring is impossible. Restorations may be made of the fractured crown to allow for placing the cap, or the cap itself may act as a means of temporary restoration. Broken down or fractured teeth can often be saved through incorporation in the cast cemented cap splint.

4. When malocclusion previous to the injury or the fracture has brought about uncorrectible conditions that must be compensated by the creation of normal occlusion through the use of cast caps.

5. When, by incorporating small brass plates fitted for twin screw or pin and screw attachments on the initial splint used for the reduction of displaced

fragments, it may be used for subsequent bone graft stabilization by the addition of intra-oral or extra-oral attachments. Similarly, attachments may be applied for the retention of intra-oral skin grafts. In this way, one splint can be used for several purposes.

The open type splint made of acrylic or cast metal, locking in the interproximal spaces by projections from a buccal and lingual flange and hinged in the back or in edentulous spaces with a button attachment for closure and stabilization, is often indicated where all or some of the teeth are affected, because of trauma, decay or periodontoclasia, and as a result are loose and of questionable stability. In this case, such an appliance acts both as a splint for the fracture and for stabilization of the teeth. Since there is no interference with occlusion, these splints can be readily adapted. They are clean and, when cemented into position, are fairly stable. I do not believe that, without cementation and interproximal wiring, they offer the stability of the cast metal cap splint, of either the open or the closed type. They are very adaptable to cases in which there are few remaining teeth, and may be supplemented with internal and external extension bars.

The use of external pin fixation has been very much talked about, especially in recent years. It has been used by some with amazing results. In the hands of certain operators, it seems the acme of achievement; in others, difficulty has been reported. In my opinion, external pin fixation has a definite place in fracture reduction and in fixation of the mandible, but it should, I believe, be used only where there is no other method of obtaining satisfactory reduction and stabilization. It is indicated in cases of extreme loss of osseous tissue in the angle, or in the body and angle, in the edentulous jaw, or in the bilateral condyle fracture when the mandible is edentulous.

In all cases, I believe external pin fixation should be supplemented by immobilization of the opposing jaw and should be kept under the closest observation. The position and stability of the pins should be maintained, with close observation of the skin incision through which they are inserted.

Intra-oral pin fixation, I believe, has little if any value in reduction and stabilization of any type of fracture with the exception, possibly, of fracture of the angle or of the ramus of the mandible. Its great hazard is the possibility of infection and ensuing loosening of the pins.

Extra-oral clamp bar fixation is a comparatively new method. It seems to provide the answer to some of the difficulties encountered in the use of external pin fixation. Its use eliminates the danger of drilling into the medullary space of the bone, resulting in bone necrosis, and the possibility of injury to the inferior dental nerve or tooth roots and of piercing the soft tissues of the mouth. It affords more definite stability than external pin fixation, since the area of bone contacted by the splint is larger and since stabilization does not depend on threaded surfaces. The incision used in introducing and in attaching the bar splint is larger than the usual pin

incisions, but the possibilities of resultant infection have been found no greater.

Headcap traction as a method of producing stabilization is often indicated, and sometimes offers the only method for stabilization of the part. Attachments, extensions and fittings of various types may be employed, the resulting traction assuring stabilization or extension in almost any direction or angle. The headcap, since it is to act as a stationary object, must be just that. Its stability depends on its covering the external occipital protuberance and its enveloping the mastoid process. The plaster headcap, which has stood the test of time, is very adaptable to any desired appliance, but it is uncomfortable to many of our patients. Modifications of the headcap have the same results without so much discomfort to the patient and do not require the laborious job of installation. Many of these modified headcaps are adjustable, and are more adaptable without sacrificing stability since they cover only the areas that are essential to stability and can be removed and replaced easily. These appliances can be constructed easily and without elaborate equipment.

The greater number of fractures coming under the Maxillo-Facial Surgery Department, being the result of gunshot wounds, show such loss of bone that bridging or approximation cannot be accomplished without loss of function and facial distortion. In such cases, bone grafting is the only solution. Statistics from World War I indicate that about 11 per cent of gunshot fractures result in nonunion and require bone grafting. This nonunion is caused by the great loss of bone substance and the inability of Nature to bridge the gap caused by bone loss when the fragments are held in their normal position. Since, in nearly all of our cases, the bone is comminuted and shattered, and often becomes infected, some necrosis and sequestration may result. Sequestration can be held to a minimum by early stabilization of these fragments. Immobilization should be secured by splints or appliances stable and rigid enough to withstand all muscle pull and action, as bone grafting requires absolute stability and over a long enough time for the graft to "take" without disturbance of its position, which must be held by a rigid trouble-free appliance.

No one type of splinting for fragment stabilization in bone graft preparation can be advocated. Since the purpose of bone grafting in the mandible is to restore as nearly normal anatomic relationship, function, occlusion and symmetry as possible, the type of splint that actually interferes the least with normal occlusion or relation and maintains the bone fragments in an immobile position is best, whatever type it may be or however it may accomplish its purpose. When teeth are present, the closed cap cast interlocking pin and flange splint furnishes the desired stabilization, being attached by cement to the teeth and otherwise by interdental wires. Interdental wiring alone cannot be entirely depended on, since there is a tendency for it to

stretch and permit motion. Cement should not be used alone since it often washes from around the teeth and a splint becomes loose, with hazardous conditions resulting. Some of these cases require extra-oral fixation in addition to the intra-oral splinting. In these, a screw plate or telescopic extension attachments joined to the rigid cast metal interdental splint can be employed. Bone graft stabilization in the edentulous mandible is a problem that must be met entirely by the ingenuity of the surgeon. It must be accomplished entirely by extra-oral fixation either from a headcap, by means of bar, pin or wire extensions, or by direct bar or pin fixation, the pins or bar lying far enough from the site of the graft itself not to endanger it from infection, which often results through the communication of bone with the surface of the skin by means of the pin itself.

Much has appeared in the literature on the importance of the electrolytic action and the different potentials of the metals used in constructing dental splints. Failure has been attributed wholly to this, bone necrosis following the use of different types of metals. It is my belief that this premise, although it has not been definitely accepted, should be considered. We do know that caution and care do pay in all surgical work. The high percentage of consolidation in bone grafting demands consideration of every detail of treatment. Stabilization preoperatively and consideration of the minutest details in producing it help to prevent failure, which is evident only when it is too late to remedy the condition.

## SUMMARY

The control of bone fragments in the treatment of fractures of the facial bones is vital. The success of all fracture treatment depends greatly on stability and immobilization. The time of treatment can in a measure be estimated, and the final result may be visualized from the success or failure of treatment. Failure to secure proper stabilization often results in faulty union and possible unnecessary loss of substance from the ends of the bones or the death of viable fragments that should not have been lost. Improper or incomplete stabilization often necessitates operative procedures that would not have been necessary had there been complete immobilization. The planning and working out of a procedure of fragment control adaptable to a particular case is paramount, whatever the means of accomplishment.

# STUDY OF ONE HUNDRED FIFTY CASES OF FRACTURE OF THE UPPER JAW IN AN OVERSEAS MAXILLOFACIAL CENTER

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From a group of injuries of the face and jaws which passed through a maxillofacial center in Italy between the months of April 1944 and February 1945, 150 cases of fractures of the maxilla have been taken for detailed study. It is hoped that scrutiny of this limited group will give a sampling of data that will prove enlightening and be fairly representative of the maxillofacial patient.

The tables appended are statistical. In the interests of brevity, soft tissue considerations have been kept at a minimum, in order that more detail pertaining to the actual fractured upper jaw *per se* may be included.

These cases were cared for and treated by fourteen medical and dental officers serving at the center for periods varying from a few days to many months.

## ETIOLOGY

Eighty-five per cent of these patients were injured under battle conditions and 15 per cent in civilian-type situations, 50 per cent suffering injury from mortar and artillery shell fragments, 20 per cent from bullets, 10 per cent from vehicle accidents and 8 per cent from a blow by a fist or a blunt instrument. Falls caused 5 per cent.

## DIAGNOSIS

*A. Diagnostic Procedures.*—1. History: How, when and where injury occurred must be unfailingly recorded and considered. Periods of unconsciousness, bleeding from the mouth, nose or ears, spinal fluid rhinorrhea or otorrhea, abnormalities of occlusion of the teeth, difficulty in swallowing or breathing, the degree and type of pain, deafness or visual disturbances—all are of great significance and may permit diagnosis of serious injuries otherwise overlooked.

Dates and places of previous hospital admissions, dates and brief descriptions of operations, wiring procedures, placement of drains or packs, transfusions and sulfadiazine and penicillin administration must be carefully extracted from the record and incorporated in the current notes to completely reconstruct the patient's care to date.

2. Physical Examination: In addition to the usual survey of the body, physical examination should include certain special details for face and jaw injuries. They should be simple, but must be performed on every patient.

*Major (MC).

*(a)* Inspection. In the record, an accurate description of all wounds, penetrating, perforating, lacerated, avulsed, contused or abraded, should be given. Intra-oral inspection should start with a recorded diagram, in the usual manner, showing all teeth present and the condition of fractured roots. Any patch of ecchymosis of the oral mucosa, all tears, protruding fragments of bone and draining oral fistulas must be observed and evaluated. If there is any appliance or wiring already in place, it may be briefly described thus: "Interdental brass loop wiring on posterior teeth, five elastics, teeth in good condition, occlusion satisfactory." If occlusion is abnormal, the fact should be stated, with a brief description of the aberration. If teeth are not wired, how many centimeters the mouth can be opened and whether the mandible deviates to the right or the left should be noted.

TABLE 1.—FREQUENCY OF OCCURRENCE OF VARIOUS TYPES OF FRACTURE OF THE MAXILLA

| Type of Fracture | No. Cases | Per Cent |
|---|---|---|
| 1. Punch type | 81 | 54.0 |
| 2. Alveolar process | 56 | 37.0 |
| 3. Undisplaced crack fracture | 18 | 12.0 |
| 4. Half of maxilla, complete | 12 | 8.0 |
| 5. Transverse, through nose and antra, complete | 6 | 4.0 |
| 6. Pyramidal, through nose and orbits, complete | 5 | 3.5 |
| Total | 178 | |

Examination by otoscope and nasal speculum should never be omitted, but may be brief at this first inspection.

*(b)* Palpation. This should include a methodical survey of all orbital borders, the index fingers being used simultaneously so that the tactile impression of the normal side may be observed to better bring out the abnormal on the opposite side. Pressure should be varied from very light to moderately firm, to feel through areas of edema, if present, in order to gage the displacement present. Nasal bones should be grasped between the thumbs or index fingers and a slow, strong force applied from side to side to determine whether fracture is present. The antra should be tested for deep tenderness by firm pressure over the canine fossae with the thumbs.

Valuable data are available from intra-oral palpation, both with a single finger and bimanually. With retraction of the lips to expose the teeth for a guide, the patient should be made to close in centric occlusion and then exert further pressure. If the upper teeth then more closely approach the level of the pupils of the eyes, a complete fracture of the entire maxilla is present. The same information may be gained by firmly grasping the alveolar process with thumb and index finger, moving with firm pres-

sure in each direction; but, when partial fibrous union has taken place, the former gives more conclusive results.

These suggestions are merely an outline. The important thing is that some orderly sequence be followed in every case, with a follow-through to further tests and procedures when a pathologic condition is found. It is important to follow some such simple routine as the foregoing at the earliest possible moment after the patient is admitted, for it will then certainly follow that the next steps in diagnosis and treatment will be automatically suggested and set in motion without delay.

3. Roentgenologic Examination: This should be made to confirm the results, and increase the scope, of physical tests, not to be a substitute for them. It also provides a dated record of conditions, which can be formed into a series of records of healing or of reduction efforts. For fractures of the maxilla, the Waters' sinus view, a posterior-anterior view of the skull which throws the orbits and antra just above the petrous portion of the temporal bones, is so highly valuable that its usefulness should be emphasized. A view

TABLE 2.—FREQUENCY OF EACH OF FIVE MODES OF COMPOUNDING

| Mode of Compounding | No. Cases | Per Cent |
|---|---|---|
| Through skin | 123 | 82 |
| Into antrum | 108 | 72 |
| Through oral mucosa | 90 | 60 |
| Into nose | 64 | 43 |
| Into orbit | 47 | 32 |
| Total | 432 | |

commonly taken at the evacuation hospitals was a straight posterior-anterior one of the skull through the maxillary region. As a survey film for foreign bodies, it should always be supplemented by a Waters' sinus view if fractures of upper facial bones are under consideration. The value of the lateral view of the maxilla is limited, except in foreign body localization, and the film should be reserved for a uniformly helpful purpose.

4. Laboratory Procedures: The copper sulfate test, which is readily performed when the setup has been arranged, gives, with the least possible labor, the hematocrit and hemoglobin determinations. The quantity of whole blood needed to restore the loss can be estimated as 1 pint for every 3 points below a normal hematocrit reading of 42 to 44. Prompt transfusion is thus encouraged, to the patient's benefit.

Urinalysis should be made on admission, to determine any existing kidney damage up to that time, and as a basis for estimating change should future abnormalities develop during the course of anticipated chemotherapy, infection, transfusions, etc.

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Determination of the sulfonamide level is desirable, but may be omitted unless a continuation of therapy already in progress is contemplated. It was our practice to request this determination every five days during sulfadiazine therapy, which was always accompanied by administration of an equal weight of sodium bicarbonate and forced fluids.

White and differential counts are of course needed to complete the picture if infection or derangement of the blood-forming organs is suspected. It was our custom to order a white and a differential count every five days and a complete blood count every ten days when patients were on sulfadiazine therapy.

*B. Classification of Types of Fractures.*—From a survey of the clinical

TABLE 3.—DISPOSITION IN RELATION TO COMPOUNDING FRACTURES*

| Number of Compoundings | Disposition | | | |
|---|---|---|---|---|
| | Duty | | Zone of Interior | |
| | No. Cases | Per Cent | No. Cases | Per Cent |
| One: 11 cases (7.5%) | 8<br>Average hospital stay 36 days | 75 | 3 | 25 |
| Two: 42 cases (26%)<br>(includes 2 deaths) | 19<br>Average hosiptal stay 45 days | 44 | 21 | 50 |
| Three: 45 cases (30%) | 21<br>Average hospital stay 47 days | 47 | 24 | 53 |
| Four: 40 cases (27%) | 6<br>Average hospital stay 82 days | 15 | 34 | 85 |
| Five: 12 cases (8%) | None | — | 12 | 100 |

*Direct relation between "number of compoundings" and (a) length of hospital stay of those who returned to duty and (b) increasing number who had to be sent to zone of interior.

material to be described, most of the fractures of the maxilla fell into essentially six groups. Although not entirely satisfying from an academic point of view, they embrace a fair compromise between type of injury and manner of treatment. Each has certain characteristics which separate it from the other groups, when fracture form and mode of treatment are considered, though anatomically the distinction may seem inappropriate. The groups are: (1) punch type, (2) alveolar process, (3) undisplaced crack, (4) half of maxilla, complete, (5) transverse, through nose and antra, complete, and (6) pyramidal, through nose and orbits, complete.

1. Punch Type: This type, an injury from a penetrating or perforating missile, might be also described as a tunnel type. The projectile, where it struck a thin plate of bone at right angles, frequently deranged the bony structure very little, giving a punched-out bone wound. If it struck a mass such as the body of the malar bone or of the mandible, carrying it inward, the destruction was apt to be severe, with a resulting detachment of a large mass of the maxilla from the skull; i.e., one of the types mentioned below. There was extreme variation in the degree of the punch type fracture. Two-thirds of the battle casualties (in this group) were of this type, which is to say 54 per cent of the whole group of maxillae.

2. Alveolar Process Fracture: Only six cases presented this fracture as their sole bony injury, and all patients returned to duty. When it was

TABLE 4.—EXTENT OF COMMINUTION

| Comminution | No. Cases | Per Cent |
|---|---|---|
| None | 16 | 10 |
| Slight | 26 | 17 |
| Moderate | 37 | 25 |
| Severe | 67 | 45 |
| Bone gap | 4 | 3 |
| | 150 | 100 |

accompanied by a more severe facial fracture, which was relatively common, the treatment was worked around the more serious phase. This term was used to describe both a shearing injury and the complete crack through the alveolar process.

3. Undisplaced Crack Fracture: This was usually produced by a blow or by contact with a low speed missile. This group had no displacement nor bone loss.

4. The Half of Maxilla, Complete: This type, with separation at or near the midline, would be expected to ensue from a blow or vehicle accident. Actually, in our series, such was the case, but an equal number were an injury from missiles, in the manner described above.

5. Transverse, Through Nose and Antra, Complete: This, the typical "guest passenger injury" of motor car accidents, occurred in our series, both from vehicle accidents and also from severe shell fragment injuries.

6. Pyramidal, Through Nose and Orbits, Complete: This injury, with the fracture line in the form of an inverted V, is noteworthy because the cribriform plate is nearly always fractured and a spinal fluid rhinorrhea results. Three of ours were from vehicle accidents and two from severe shell wounds. These five pyramidal fractures comprised five of the seven

cases that presented spinal fluid drip. Of the other two, one was a transverse and one a penetrating wound of the brain from a shell fragment.

*C. Diagnostic Features Peculiar to Maxillary Fracture.*—1. Antra-Oral Fistula: This was averted many times by prompt reparative surgery in field and evacuation hospitals. Ten of our cases, or 6 per cent, presented well-established fistulas of this type, varying from a few millimeters to several centimeters in diameter. This subject is further discussed under complications.

2. Antra-Nasal Fistula: This is one of the few results of missile injury that can be regarded as actually helpful. These antra did very well as a group, and the orifice, when it was low, served as a surgically constructed window, for ventilation and drainage of the sinus.

TABLE 5.—DISPOSITION IN RELATION TO COMMINUTION*

| Comminution | Disposition | | | |
|---|---|---|---|---|
| | Duty | | Zone of Interior | |
| | No. Cases | Average Hospital Stay of Duty Cases Days | No. Cases | Percentage of Each Group |
| None | 13 | 44 | 3 | 23 |
| Slight | 12 | 44 | 14 | 59 |
| Moderate† | 14 | 48 | 22 | 62 |
| Severe | 17 | 40 | 50 | 73 |
| Bone gap† | None | — | 3 | 75 |

*There is a direct relation between severity of comminution and tendency to go to zone of interior, but not with number of hospital days of duty cases.

†There was one death each in moderate and bone gap groups.

3. Perforation of the Palate: This condition, on the other hand, created the above-mentioned conflict between nasal and oral bacterial flora, with the additional factor of symptoms related to speech and eating such as are found in congenital cleft palate. These wounds showed a strong tendency to grow smaller or even close completely, a phenomenon which we did not see fit to interfere with by surgical intervention as long as spontaneous closure was continuing. Thirteen, or 8 per cent, of our 150 cases presented this abnormality on admission.

4. Antral Fistula, Through the Skin: This fistula had been closed in the primary surgical operation in most cases, as the abundance of freely movable soft tissue invited repair. In a few cases, when the defect was very large,

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the patient was surprisingly comfortable and managed quite well, in the absence of perforation of the palate or antra-oral fistula.

*D. Estimate of Severity of Cases.*—Sixty-two per cent required further care or disposition in the United States; two patients, or 1.3 per cent, died after being received here. Eighty-two per cent of fractures were compounded through the skin, 72 per cent compounded into the antrum and 60 per cent into the mouth. (Tables 2 and 3.)

Comminution was rated as severe in 45 per cent, moderate in 25 per cent and slight or absent in 27 per cent. (Tables 4 and 5.)

Bone loss was severe in 11 per cent, moderate in 29 per cent and slight or none in 60 per cent. (Tables 6 and 7.)

Displacement was of scattering type in 14 per cent, downward (large segment) in 22 per cent and crushed inward in 7 per cent. (Table 8.)

The maxilla was fractured alone in only 25 per cent, and with other

TABLE 6.—BONE LOSS

| Bone Loss | No. Cases | Per Cent |
|---|---|---|
| None | 52 | 34 |
| Slight | 39 | 26 |
| Moderate | 44 | 29 |
| Severe | 15 | 11 |
| | 150 | 100 |

facial bones in 75 per cent. (Table 9.) Table 10 presents other combinations.

From these data, a rough composite picture may be had. Further details regarding the group are given in the various tables.

## TREATMENT

*A. Early Care.*—1. Procedures in Forward Installations: A detailed tabulation will be found in Table 11, but some of the more frequent procedures may be mentioned here for emphasis: eighty-four primary closures, twenty-four débridements, thirty-three intermaxillary fixations, nine Caldwell-Luc operations and seven tracheotomies.

This list may seem to include surprisingly little regarding the care of the fracture itself. The explanation is found in Table 1, listing types of injury incurred. The large group of punch or tunnel type fractures is significant, for with them the problem is not fixation, but, rather, one of débridement of the "bone wound" and soft tissue wound at the same time, with primary closure of the latter if at all possible. It is this intrinsic difference which characterizes war wounds of the maxilla as contrasted with those of the mandible.

2. Evaluation of Work Done in Forward Hospitals: While many of the patients requiring intermaxillary fixation had the appliance in place when they arrived here (thirty-three of them), there yet remained twenty-three more on whom all wiring was done at this hospital, after a delay of several days. There was no significant difference in the progress of these two groups, as far as the ultimate union of the maxilla was concerned (i.e., only three maxillae developed any degree of nonunion in the entire group of 150).

On the other hand, when soft tissue wounds were left open for periods up to one or two weeks, a low-grade surface infection developed, attended by gradual laying down of scar tissue and increasing disability. I wish to stress the reverse emphasis that is here implied, as varying from previous

TABLE 7.—DISPOSITION IN RELATION TO AMOUNT OF BONE LOSS*

| Bone Loss | Disposition | | | |
|---|---|---|---|---|
| | Duty | | Zone of Interior | |
| | No. Cases | Average Hospital Stay of Duty Cases Days | No. Cases | Percentage of Each Group |
| None | 34 | 44 | 18 | 33 |
| Slight | 11 | 47 | 28 | 69 |
| Moderate† | 8 | 56 | 35 | 79 |
| Severe† | 2 | 18 | 12 | 92 |

*There is a direct relation between amount of bone lost and tendency to go to zone of interior.
†There was one death each in moderate and severe groups.

conceptions and directives in war surgery of face wounds, wherein it was advised that even face wounds be left open, to prevent dangerous infections, and that, at virtually all costs, lateral segments of facial bones be retained in place.

We are of the opinion, after seeing all variations of primary suturing, that disfigurement and deformity can be prevented to a great extent by meticulous primary débridement and layer repair as soon after injury as possible. There appears to be no sharp limit to the period in which primary repair can be successfully carried out, but it seems that, with average conditions of weather and bodily state and complicating wounds, any time would be as suitable as the first twelve hours. If the patient was not brought to the hospital for four days, and was in good condition, this would be the most suitable time for débridement and primary closure for that patient.

In brief, while it would be ideal to treat soft tissue injuries and bony displacements at the same time and within a few hours after injury, circumstances seldom permit this opportunity. From this vantage point in the chain of evacuation, we were able to see repeatedly that the patients who had been submitted to early and careful, albeit lengthy and tedious, layer repair of facial defects, were "way ahead of the game" as contrasted with those who had had wounds debrided and left open. These large open wounds required daily changes of soggy, malodorous dressings. While early reduction and fixation of facial fractures are also highly desirable, if only a certain amount of time and energy is available for a given case first attention should be in the direction of closing soft parts. Often, this

TABLE 8.—DISPLACEMENTS AND FREQUENCY OF EACH TYPE

| Type of Displacement | No. Cases | Per Cent |
|---|---|---|
| No displacement or scattering | 83 | 55 |
| Scattering of fragments, no displacement of body of bone | 22 | 14 |
| Dropping downward of fragment or entire maxilla | 31 | 22 |
| Lateral displacement of half or entire maxilla | 3 | 2 |
| Inward crushing of wall of antrum | 11 | 7 |
| | 150 | 100 |

TABLE 9.—RATIO OF SOLITARY TO MULTIPLE FRACTURES

| Fractures | No. Cases | Per Cent |
|---|---|---|
| Maxilla alone fractured | 37 | 25 |
| Maxilla plus other facial bones fractured | 113 | 75 |
| | 150 | 100 |

may require the rotation of contiguous immediate flaps, which, when ventured, usually survived well.

According to further observations on care at forward hospitals, a somewhat overly conservative policy had been followed regarding extraction of teeth; intermaxillary elastic traction had nearly always been chosen when occlusal fixation was needed; all necessary tracheotomies had been carried out with one exception, and bandages were of infinite variety. Observation gave the impression that it was desirable to follow any primary suturing or repair with a firm bandage made of: fine mesh gauze, 4 by 4 gauze squares, ABD pads, elastic roller bandage and adhesive tape attached to bandage and adjacent skin, applied in the sequence named. Wounds so dealt with showed little postoperative edema. Dead spaces were obliterated by compression, and the wound was splinted and kept free of pain.

If proper pressure dressings had been used, it little mattered whether a slip of rubber dam was provided for an exit valve. It is my preference to use one in all but the simplest wounds.

*B. Intermediate Care.*—Upon arrival at this center, the diagnostic routine outlined above was carried out; careful records were made on the spot, and therapy was instituted without delay. On receipt of the report on the copper sulfate test, blood was given in the quantity needed and as soon as possible. If penicillin or sulfadiazine therapy had been started, the course was continued in most cases to complete one week, and then other courses of one drug or the other were administered as indicated. Intravenous glucose and plasma were needed less frequently at this stage

TABLE 10.—TABLE OF COMBINATIONS OF FACIAL BONES FRACTURED, WITH DISPOSITION OF EACH*

| Fracture | No. Cases | Per Cent | Disposition | | | |
|---|---|---|---|---|---|---|
| | | | Duty | | Zone of Interior | |
| | | | No. Cases | Per Cent | No. Cases | Per Cent |
| Maxilla alone | 37 | 25 | 19 | 53 | 18 | 47 |
| Maxilla and mandible (includes one death) | 33 | 22 | 9 | 27 | 23 | 70 |
| Maxilla and malar | 22 | 14 | 15 | 67 | 7 | 32 |
| Maxilla and nasal | 15 | 10 | 5 | 33 | 10 | 66 |
| Maxilla, malar and nasal | 12 | 8 | 1 | 8 | 11 | 92 |
| Maxilla and other facial bone (vomer, ethmoid, etc.) (includes one death) | 8 | 5 | 2 | 25 | 5 | 63 |
| Maxilla, mandible, malar and nasal | 5 | 3 | 2 | 40 | 3 | 60 |
| Maxilla, mandible and malar | 15 | 10 | 2 | 13 | 13 | 87 |
| Maxilla, mandible and nasal | 3 | 2 | — | — | 3 | 100 |
| Total | 150 | 100 | 55 | | 93 | |

*No cases of fracture of the mandible alone were included in this study.

of the evacuation than they were forward. Indwelling nasal-gastric tubes were placed without delay when swallowing required painful effort, and, through this tube, frequent small feedings, plus needed oral medicaments, were given. Continuous hot saline packs were applied to all areas which exhibited any degree of swelling or sepsis. Hourly hot water irrigation with enema-type can and tube was needed in the severe injury cases in which there was mouth breathing or suppuration into the oral cavity. The same procedure, using saline packs, was employed in the nose showing much crusting, and even in antra when the aperture into the mouth was large. In all cases with teeth wired, spraying followed each feeding and the patient was encouraged to brush the teeth as often as possible. When

TABLE 11.—TABULATION OF TREATMENT PROCEDURES PERFORMED (A) AT FORWARD HOSPITALS AND (B) AT THIS CENTER IN 150 CASES OF FRACTURE OF THE MAXILLA

| Procedure | In Forward Hospitals | At Maxillofacial Center | Total | Percentage of 150 Cases |
|---|---|---|---|---|
| Primary suture of facial wound | 84 | 3 | 87 | 58.0 |
| Primary wiring of teeth and intermaxillary fixation | 33 | 23 | 56 | 37.0 |
| Metallic foreign body removal | 35 | 3 | 38 | 24.0 |
| Débridement only, of facial wound | 24 | — | 24 | 16.0 |
| Caldwell-Luc operation (modified) | 9 | 14 | 23 | 15.0 |
| Transfusions (on 22 patients, 34 transfusions) | ? | 22 | ? | 14.0+ |
| Tooth extraction procedures | 2 | 19 | 21 | 14.0 |
| Sequestrectomy or "spiculectomy" | 5 | 12 | 17 | 11.0 |
| Secondary closure | — | 16 | 16 | 9.0 |
| Elevation of malar bone (5 Gillies, 7 by other means) | 5 | 7 | 12 | 8.0 |
| Secondary or rewiring procedures | — | 11 | 11 | 8.0 |
| Support of maxilla by means of chin support (elastic strap or Woodward POP cap) | 5 | 5 | 10 | 6.0 |
| Tracheotomy | 7 | 1 | 8 | 5.0 |
| Scar adjustment or excision | — | 6 | 6 | 4.0 |
| Closure of fistula (1 palate perforation, 1 antra-oral fistula, 4 of cheek) | — | 6 | 6 | 4.0 |
| Incision and drainage | — | 5 | 5 | 3.0 |
| Skin graft | — | 5 | 5 | 3.0 |
| Construction of nasal window alone | 1 | 4 | 5 | 3.0 |
| Direct bone wiring | 3 | 2 | 5 | 3.0 |
| Plaster headcap, traction wires through cheeks, to support maxilla | 4 | 1 | 5 | 3.0 |
| Tube feeding, indwelling | 1 | 3 | 4 | 2.6 |
| Severance of synechia of nares | — | 4 | 4 | 2.6 |
| Acrylic splint | 2 | — | 2 | 1.3 |
| Secondary reduction of fractured nasal bones | — | 2 | 2 | 1.3 |
| Deep alcohol injection | — | 1 | 1 | 0.6 |
| Submucous resection | — | 1 | 1 | 0.6 |

necessary, this therapy was carried out on bed patients by the medical corps enlisted men, but all afebrile patients were urged to get up and about as quickly as possible, and to attend to their own hot packs, irrigations, feeding, shaving and general care.

In Table 11 is found a list of the therapeutic procedures rendered in the 150 cases, exclusive of the routine items mentioned above. While the primary function of this center was the accumulation of data to more fully comprehend the problem of the maxillofacial patient, it will be seen that not a small amount of effort was still necessary simply to "carry them along," give every opportunity for healing, attempt to minimize fibrosis and

deformity whenever possible and, in short, cure the disease and return the man to duty when this goal could be achieved through one-stage operations. What might have been accomplished had the theater policy permitted more of the reconstructive type of procedure is a matter for conjecture. Restraint in this regard is difficult, for the boundary line between reparative and reconstructive measures is indefinite. When evacuation to the zone of the interior is intermittent and irregular, an orderly prospectus for each case is often difficult.

With regard to the "intermediate" care, it must be said that the picture is not completely painted by enumeration of the surgical and clinic procedures. Wounds of the face cannot be left bandaged for twelve to four-

TABLE 12.—COMPLICATIONS*

| Complication | No. Cases | Per Cent |
|---|---|---|
| Maxillary sinusitis | 80 | 53.0 |
| Trismus | 17 | 11.0 |
| Atresia of nares | 15 | 10.0 |
| Soft tissue abscess | 11 | 7.0 |
| Chronic antra-oral fistula, persisting after first operation | 10 | 6.0 |
| Osteomyelitis of maxilla | 8 | 5.0 |
| Nonunion of concurrent mandibular fracture | 7 | 5.0 |
| Severe neuralgia of face due to injury | 4 | 2.6 |
| Nonunion of maxillary fracture | 3 | 2.0 |
| Osteomyelitis of mandible | 3 | 2.0 |
| Pneumonia | 3 | 2.0 |
| Meningitis | 3 | 2.0 |
| Cerebral concussion | 2 | 1.3 |
| Death | 2 | 1.3 |
| Anuria, following shock and transfusions | 1 | 0.6 |
| Malaria | 1 | 0.6 |
| Toxic psychosis | 1 | 0.6 |
| Hepatitis, mild | 1 | 0.6 |

*Occurring before admission to maxillofacial center, as well as those evident at this center.

teen days as might be done with a similar size injury of an extremity. The seepage of serum, saliva, nasal mucus, tears and frank pus, not to mention the spillage from liquid diet, combine to make frequent changing unavoidable, a time-consuming procedure. Elastic bands are continually breaking or coming off, and diligent efforts are required to prevent nasal and antral crusts from accumulating to the point of impaction. The above-mentioned hot packs and irrigation, sulfadiazine therapy, penicillin administration and transfusion and careful recording of all these steps require much time and alert attention.

*C. Late Care.*—A glance at Table 15 will show the type of surgical procedure still indicated for the group which were sent to the United States for further care or disposition. In general, it is the staged procedure,

multiple excision of scars, delayed flaps, bone grafts, cartilage implants and fascial strips for facial paralysis, which remained to be completed. Some, such as those who had lost an eye, will doubtless be separated from the service, but at least a third of the whole group could have been salvaged for further overseas duty had an additional two or three months been allowed, and had the shortage of personnel required that degree of salvage.

COMPLICATIONS

*A. Maxillary Sinusitis.*—This was the most frequent complication in our cases. It is virtually impossible to fracture the body of the maxilla without producing some degree of hemorrhage into the antrum. Nature is able to cope with the situation unaided in about half the cases. An

TABLE 13.—DISPOSITION OF THE 150 CASES

| Type of Duty or Disposition | No. Cases | Per Cent |
|---|---|---|
| Full duty overseas | 37 | 25.0 |
| Limited duty overseas | 18 | 11.7 |
| Zone of interior | 93 | 62.0 |
| Died | 2 | 1.3 |
| | 150 | 100.0 |

artificial nasal window created by a missile wound, as previously stated, may well decide the outcome, giving ventilation and drainage fully as satisfactorily as a surgical aperture. Previously existing sinusitis doubtless played a role in setting the stage for active infection following injury, in some instances. As shown in Table 12, 108 cases, or 72 per cent, showed fracture into the antrum; eighty cases, or 53 per cent, showed some degree of sinusitis either clinically or roentgenologically, and twenty-eight cases, or 18 per cent, required either a Caldwell-Luc operation or antral window construction rather urgently. It is interesting to note that this procedure was required three times as often in injuries not from missiles as from those caused by a projectile.

*B. Trismus.*—As would be expected, trismus was temporarily present in nearly all face cases with injury near the mandibular joint, and in or near the vertical masticatory muscles (masseter, temporal and internal pterygoid). It constituted a major late consideration in only seventeen cases, or 11 per cent. A noteworthy point is that all but one were missile injuries, and all but two presented fracture of the mandible as well.

*C. Atresia of Nares.*—This condition complicated fifteen cases, all but one missile cases, making 11 per cent of that group, and was a factor in sending to the zone of the interior 13 per cent of all who went home, in this group of 150 cases. The mechanism varied from slight scarring

due to partial loss of an ala to complete destruction of the nostril from loss of the lining and supporting tissues.

*D. Wound Sepsis.*—This is a difficult thing to appraise because of the multiplicity of indices to be considered, but it was, for the most part, far less common than was anticipated. That is to say, virtually no instances of deep, spreading cellulitis, of Ludwig's angina, of cavernous sinus thrombosis, etc., were encountered. In eleven cases, or 7 per cent, frank abscess occurred, but it was readily controlled by the usual measures, including incision and drainage. Penicillin therapy and the oral administration of sulfadiazine have doubtless done much to account for this low figure, but it is our considered opinion that correct and timely surgical measures are of vastly greater significance.

*E. Chronic Antra-Oral Fistula.*—Such a fistula remained, after primary surgical treatment of the original wound, in ten cases, all in the missile

TABLE 14.—DISPOSITION OF BATTLE CASUALTIES VS. INJURIES

| Type | Disposition | No. Cases | Per Cent |
|---|---|---|---|
| Battle casualties: 125 cases | Full Duty | 20 | 15 |
| | Limited Duty | 18 | 14 |
| | Zone of Interior | 85 | 70 |
| | Died | 2 | 1 |
| | | 125 | 100 |
| Injuries: 25 cases | Full Duty | 17 | 68 |
| | Limited Duty | None | |
| | Zone of Interior | 8 | 32 |
| | Died | None | |
| | | 25 | 100 |

group, and in 8 per cent of the fractures caused by such agents. The small ones tended to close of themselves, and others would have lent themselves to surgical operation overseas with relative assurance of success, but when other conditions, such as the loss of an eye and radial nerve paralysis, demanded that a patient be sent to the zone of the interior, his departure was not delayed by incidental operations.

*F. Malocclusion.*—This complicated 5 per cent of all cases, but most of the difficulties were satisfactorily surmounted by gradual intermaxillary elastic traction. In some instances, secondary refracturing operations were required to correct the malposition, usually with no more delay than in cases reduced at the outset.

*G. Osteomyelitis.*—Osteomyelitis of either mandible or maxilla occurred in 5 per cent of patients, a rather liberal definition of the term applying.

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The criterion was the discharging of dead fragments of bone and a prolonged purulent drainage, even though the bone fragments were those knocked loose at the time of impact. Classical osteomyelitis, with mass necrosis of bone, was notably absent, an interesting fact in view of the amount of violent trauma, potential infection and decreased vitality of tissue. All this serves to show why primary closure can be freely urged in this type of work on the face, particularly when the patient can be under chemotherapy.

*H. Secondary Hemorrhage.*—This is mentioned merely to state that it did not occur in this group of cases. In the entire group of cases at the center, only three cases of secondary hemorrhage occurred, and they were

TABLE 15.—TABULATION OF REASONS FOR SENDING PATIENTS TO ZONE OF INTERIOR*

| Reason | No. Cases | Percentage of 93 Cases |
|---|---|---|
| Severe soft tissue loss or deformity | 34 | 36.0 |
| Severe bone loss or deformity | 22 | 23.0 |
| Severe injury of other part of the body | 19 | 20.0 |
| Enucleation or blindness | 18 | 19.0 |
| Deafness or chronic otitis media | 15 | 16.0 |
| Atresia of nostril | 13 | 13.5 |
| Chronic antra-oral fistula or severe chronic maxillary sinusitis | 13 | 13.5 |
| Seventh nerve paralysis | 13 | 13.5 |
| Severe trismus | 10 | 10.7 |
| Defect of palate | 8 | 8.6 |
| Nonunion of maxilla or mandible | 8 | 8.6 |
| Severe neuralgia of face | 3 | 3.2 |
| Chronic osteomyelitis of maxilla or mandible | 3 | 3.2 |
| Diplopia, due to dropping of orbital floor | 3 | 3.2 |
| Severe malocclusion, resulting from injuries | 2 | 2.1 |
| No urgent reason evident here, but already boarded at other general hospital | 2 | 2.1 |
| Large metallic foreign body deep in face | 1 | 1.1 |

*The total of reasons exceeds ninety-three since many patients were sent for several defects, applying to a varying degree. It does not follow that each item would necessarily have sent the man home, unless it were present to a severe degree.

all in the mandibular or upper neck area. When present, it is usually related to sepsis adjacent to a sizable vessel, with resulting erosion of the wall.

*I. Nonunion.*—Nonunion of fractures of the maxilla resulted in three cases, or 2 per cent, and there was nonunion of seven mandibular fractures in this group as well. The problem is quite different in the two bones. Fractures of the maxilla usually undergo firm fibrous union quite rapidly, unless fixation is lacking and some mechanism is present that produces constant movement of the detached segment. Since the maxilla is not a

long bone, the effect of leverage and muscle pull does not apply as in the case of the lower jaw. Not only is nonunion of the maxilla less common than that of the mandible, but its occurrence is also of less concern; for if the motion is attended by any degree of pain or discomfort, immobility can be achieved by an open operation, freshening of bone margins and direct wiring with stainless steel wire. Bone grafting is seldom resorted to unless the gap is very wide.

With the mandible, comfort, function and freedom from sepsis are largely dependent on firm bony union, since it is a long bone, with various muscle attachments along its length. Any interruption in its continuity is attended by some disability, which may or may not be sufficiently severe to require bone grafting.

*J. Neuralgia.*—In only four cases was there sufficiently severe neuralgia of the face following wounds to warrant taking steps to alleviate the pain. It was a constant source of amazement to us to hear, on daily rounds, the complaints of numbness of this or that facial area, with virtually no one reporting neuralgic pain. Intermediate effects, of paresthesia, were fairly frequently seen. All but one of the neuralgia cases tended to improve with time, this suggesting that, in the depth of the tissues, as well as on the visible surface, a kaleidoscopic change is constantly going on during the first three to six months of healing. In the one case, complete success was achieved by blocking the second division with 95 per cent alcohol, in the pterygomaxillary fissure.

*K. Systemic Disease.*—Major systemic disease complicated relatively few of these cases: pneumonia and meningitis, each, in three, malaria and hepatitis, each once, and anuria due to kidney block attending shock and transfusion reaction in one. The first two groups were treated with sulfadiazine and other supportive measures. The malaria was brought under prompt control with atabrine, and the hepatitis case was mild, recovery occurring spontaneously.

*L. Deaths.*—One death occurred within twenty-four hours of admission. There was severe shell fragment mutilation of the face, with fractures of upper and lower jaws and avulsion of most of the mandible. No urine was passed at this hospital prior to death, and necropsy revealed large amounts of decomposing blood elements in the glomeruli and tubules.

The other death was that of an officer, which occurred five days after admission here, the patient having suffered shell fragment wounds of the lower lip, upper and lower alveolar ridge areas and posterior pharyngeal wall. He was somewhat hypomanic and disoriented when received here, large doses of paraldehyde and other sedatives being required to keep him in bed. He received sulfadiazine and penicillin in ample doses, nasal oxygen, even tracheotomy to assure adequate oxygen tension in the lower respiratory tract, high caloric feedings through a tube, etc. Terminal pneumonia devel-

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oped and death occurred the thirteenth day after injury. Necropsy did not reveal definite evidence of meningitis. It was felt that the behavior constituted a major psychosis, induced or aggravated by the nature of the injuries and battle experiences, in addition to which the pneumonia was more of a load than could be carried.

## DISPOSITION

Disposition has been mentioned above as the most obvious criterion of success in military surgery. The function of the medical department is to conserve manpower and, in each specific case, return the patient to front line duty if possible, in the shortest possible time. When this could not be accomplished in ninety days (at times, 120 days was permitted if there was assurance that the man would return to full duty), the patient was returned to the United States for further treatment or disposition.

The attached tables tend to show rather strongly that to a large extent disposition of a case is settled the moment the soldier is hit on the field of battle. (Tables 3, 5, 7, 10 and 15.)

At the outset of this survey, it was a point of considerable speculation as to what the figures would show regarding ultimate disposition of patients with the maxilla alone fractured, as against those with the mandible alone fractured, and of the group with maxilla and mandible fractured. With the help of a parallel study on mandibular fractures, it was found that (a) when either maxilla or mandible alone is fractured, almost exactly 50 per cent of patients are returned to duty and 50 per cent go to the zone of the interior, and (b) when both maxilla and mandible are fractured, only 25 per cent are returned to duty and 75 per cent go to the zone of the interior.

In the over-all study of 150 cases of fractured maxilla, with or without other facial fractures, 33 per cent returned to duty overseas.

Disposition as related to types of compounding has been previously shown (Table 3) to be directly related to disposition, so that the twelve cases with all five types of compounding all went to the zone of the interior. The percentage decreased from 100 per cent as the number of compoundings decreased.

Of the 125 who were battle casualties, one-third returned to duty and two-thirds went to the zone of the interior. With the twenty-five civilian-type injuries, the ratio was exactly reversed: two-thirds of the patients returned to duty and one-third went home. Thus, the greater severity of war injuries is evident.

Ninety-three patients, or two-thirds of the entire group, went to the zone of the interior for disposition or further treatment. Of these, one-third went because of soft tissue mutilation (with or without other reasons), one-fourth went for bony loss or deformity of the face and one-fifth each for blindness

and severe wounds of other parts of the body. Of the ninety-three patients sent to the zone of the interior, roughly one-fifth went for other reasons than maxillofacial injuries. In other words, it can be assumed, for purely statistical purposes, that they would have returned to duty from the standpoint of their face wounds.

## SUMMARY

1. One hundred fifty patients with fracture of the upper jaw were studied with a view to determining the characteristics, severity and complications of their injuries, and the methods of treatment used.

2. The commonest type was a penetrating or perforating bone wound—the "punch type" fracture.

3. These fractures are severe, two-thirds requiring further treatment in the United States, the patient being unable to return to duty in ninety days.

4. Maxillary sinusitis was a frequent complication, as many of the fractures were grossly compounded into the antrum through either skin or oral mucous membrane.

5. The modified Caldwell-Luc type procedure has multiple functions and should not be withheld when the indications for its performance are clear.

6. Intermaxillary fixation is not required in so many of these fractures as in the case of the mandible, since, in many missile fractures of the upper jaw, an intact dental arch remains and the maxilla is not detached from the skull.

7. Careful débridement and primary closure of the face wounds over these fractures not only obviates many fistulas, but also greatly eases the later burden of dressings and minimizes fibrosis due to surface sepsis, and, in these cases, was not attended with serious infection as a result of the closure.

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# CORRECTION OF ABNORMAL MANDIBULAR PROTRUSION BY INTRA-ORAL OPERATION*

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The ability to function satisfactorily in the mastication of food in spite of surgical or traumatic interference with the subcondylar structure of the mandible has been demonstrated to the profession on many occasions, particularly to those who have in recent years been called on to treat excessive traumatic injuries of the maxillofacial bones.

It has been more or less universally accepted that a result should be considered satisfactory if masticating function and esthetic values can be restored, even though the roentgenographic evidence of realinement of fragments or restoration of anatomic position has not been demonstrated.

There are those who still believe that a satisfactory reduction cannot be accomplished unless there is an open operation and direct wiring in all cases of displaced fragments in subcondylar fractures. Experience has taught us that, even when fragments are not realined in their original anatomic position, one can go through life with satisfactory function. This is, of course, at variance with treatment of fracture involving other joints in the body, particularly the long bone, where a result cannot be accepted in which the parts are not anatomically realined.

Many cases have been reported wherein complete displacement of the condyle from the glenoid fossa or removal of the condyle has not seriously interfered with a satisfactory use of the jaw.

It is by reason of this experience that many of us have ventured, by surgical bisection of the rami, to correct excessive protrusion of the mandible wherein either the extreme protrusion or the age of the patient has prevented the use of orthodontic methods to correct this facial and functional deformity.

Surgical correction of abnormal protrusion of the mandible has been attempted and reported since 1849, when Hullihen[1] recorded his operation for correcting a case of "elongation of the underjaw." Since that time, a relatively small number of surgeons have attempted operations for correction of this and similar deformities. Hensel[2] has given a historical background for these operations and has compiled a complete bibliography.

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1. Hullihen, S. P.: Case of Elongation of Under Jaw. Am. J. D. Sc. 9:157-165, 1849.

2. Hensel, G. C.: Management of Fracture of Mandible. Surg., Gynec. & Obst. 55:238-243, August 1932; Surgical Correction of Mandibular Protraction, Retraction and Fractures of Ascending Rami. Surgery 2:92, July 1937; Internat. J. Orthodontia 23:814, August 1937.

It will be obvious to those interested in this branch of surgery that the operation here described can be employed only in that type of deformity which can be corrected by horizontal bisection of the ramus and in which protrusion does not exceed two-thirds of the width of the ramus at the point of bisection just above the mandibular sulcus.

By this method, the angle of the division cannot be one of choice in most cases because the angle of the saw cut must be determined largely by the accessibility to the field. This is predetermined by the vertical dimension between the occlusal surfaces of the maxillary and mandibular molar teeth when the mouth is opened to permit entry of the fingers and instruments of the operator.

If it were not for the latitude allowed when displacement of the fragments occurs, both as the result of manual reduction of the lower fragment into occlusion and muscle traction on the superior fragments, this operation would not be universally successful. If an optimum angle for division of the rami is selected and the bisection made on this line, there is no way of controlling the various angles of displacement of the superior portion of the ramus above the division. Most surgeons who have performed the operation of rami bisection will, I believe, agree that there are many cases in which the fragments have drifted into such displacement that there has been overriding and, even in these cases, they have obtained satisfactory functional and esthetic results.

In view of the satisfactory results obtained in operating in such cases, I do not believe that any meddlesome procedure employing skeletal fixation to maintain an optimum relation between the two fragments is advisable. The small amount of bone structure in the superior fragments between the cut and the mandibular notch would not permit installation of bone pins without a potential deleterious side-effect. Perforation of the parotid gland and the multiple facial scars left after withdrawal of the bone pins would be undesirable and unnecessary.

One of the principal hazards described by most of the surgeons performing this operation through an external incision is possible damage to the facial nerve. In the operation employed by me, this particular hazard is eliminated; and, if the procedure here described is performed carefully and accurately, I see no reason that, in the hands of a skilful operator, this should not become the operation of choice in all cases wherein horizontal division of the rami is regarded as the best method for correction of the deformity.

Various methods have been employed to correct excessive protrusion, virtually all necessitating incisions through the external surface of the face. Removal of a section of bone bilaterally from the body of the mandible is still practiced by certain surgeons. A greater number who perform this corrective operation have embraced a technic for division of the rami using

a Gigli saw. This is passed from the facial surface at the posterior border of the ramus through the soft tissues and close to the internal surface, forward to the anterior border of the ramus and out through the cheek. The division is accomplished by drawing the Gigli saw through the two incisions, one back in the parotid region and the other anteriorly through the masseter and buccinator muscles. Although the scars, in most cases, have not been extensive, there are evidences of operation which could be avoided by use of another method in many cases.

An intra-oral route for this procedure has always been looked on with

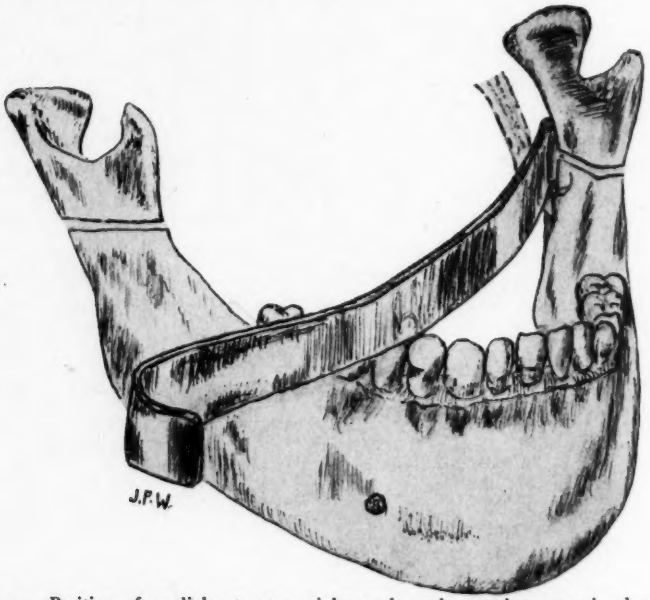


Fig. 1.—Position of medial retractor; right angle end engaging posterior border of ramus. The inferior alveolar structures and other tissues attached to the internal surface of the ramus are held medially by the back of the retractor.

apprehension because of the danger of infection from the oral cavity. Those who have had a wide experience in major traumatic maxillofacial injuries are not unduly concerned over the possibility of infection from this source except when extensive surgical manipulation, such as direct wiring, has been instituted and the fragments have been subjected to prolonged periods of manipulation and surgical preparation.

When infection does occur in such cases, early drainage and elimination of a prolonged retention of pus seem to be the answer to rapid and uneventful recession of the infection.

Since the advent of the sulfa drugs and penicillin, many unsatisfactory results of treatment of wounds of this type have been eliminated. Surgeons have been given a great deal of confidence in treatment and closure of wounds, which heretofore had to be kept open and drained for long periods of time; a fact which in itself impeded primary union in compound fracture.

Patients for whom bisection of the rami is indicated have little to lose. They have little or no masticating surfaces in occlusion and, because of their facial deformities, they are more or less socially ostracized.

The possibility of failure to reestablish bony union is one requiring con-

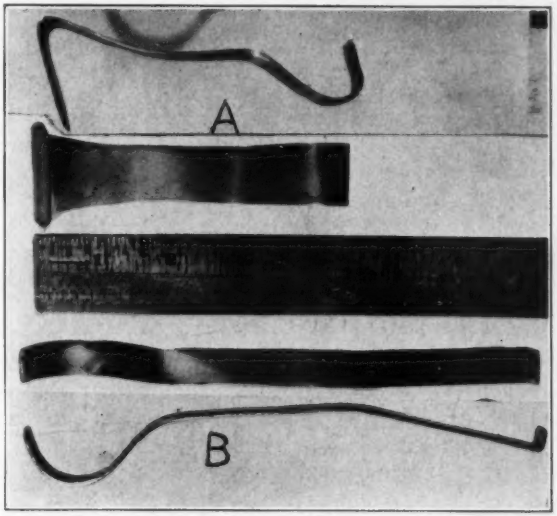


Fig. 2.—*A*, retractor used externally or buccally. *B*, retractor used medially and to engage posterior border of ramus.

sideration, and the result should this not occur is a question that must be answered.

Here again, we must return to our experience in handling traumatic injuries. It is generally known that many persons who have never obtained a bony union in jaw fracture have gone through life oblivious of the fact and with function, as well as esthetic values, satisfactory to them. This, after all, is our ultimate objective. The principal objection to the intra-oral route in bisection of the ramus is not different from that in other intra-oral operations on the ramus. Access and the adequacy of exposure to the region are of primary importance. It therefore becomes necessary to select or design a retractor of simple construction that will enable the

assistant to retract the tissues, buccally and medially, to give access to and vision of that portion of the ramus to be divided. For external retraction, I use a broad concave retractor with a convex end conforming to the anterior border of the ramus. This is held firmly against the external oblique line of the ramus while traction is being exerted externally, holding the cheek well out of the field of operation. A second retractor, used for medial traction, is a ribbon type about a half inch wide, the distal end of which is bent at a right angle for a distance of about one-eighth inch. This turned-over end permits engagement of the posterior border of the ramus after the retractor is passed through the wound. The other end is bent in the opposite direction, forming a handle to be easily grasped with one hand. Medial traction then is permitted by the elasticity of the tissues, provided, of course, incision, dissection and elevation are sufficient to permit stretching of the tissues attached to the internal surface and anterior border of the ramus.

As the point for bisection is preferably just above the mandibular sulcus, the incision for exposure should be from a point about 3 cm. above the occlusal plane of the molar teeth down to that plane. The primary incision is made by sharply incising along this line down to the bone, after which the tissues are bluntly dissected from the anterior internal border (internal oblique line) and moved medially until the lingual nerve has been identified and the structures entering the inferior alveolar canal have been demonstrated and are contained well within those tissues held medially by the retractor. When the entire internal surface of the ramus above the mandibular sulcus has been exposed for the distance necessary for passage of the medial retractor, this instrument is inserted until the posterior border of the ramus is engaged by the right angle one-eighth inch bend of the retractor. Stretching of the inferior alveolar vessels and nerve constitutes a considerable degree of trauma and is responsible, no doubt, for the paresthesia experienced by certain patients after the operation. This is of no greater importance than the paresthesia experienced after any operative procedure involving trauma of the inferior alveolar nerve. After adequate exposure of the field, the procedure of importance is selection of a saw with which to make the division.

In an endeavor to carry out this operation intra-orally, I had long sought a suitable type of manually propelled cross-cut bone saw and had tried various types of nasal and small orthopedic bone saws. All that were tried were found unsatisfactory and presented great difficulty, as well as being time consuming for effective results, because of the limitation of length of stroke that was possible without injury to the structures back of the ramus. For these reasons, the intra-oral operation was temporarily abandoned.

It was not until Dr. O. K. Bullard suggested to me the use of an orthopedic power-driven short-stroke cross-cut saw that I resumed using the

intra-oral route for this operation. The saw was designed and is manufactured by Dr. E. A. Cayo, of San Antonio, Texas, for other orthopedic procedures. It is far from an ideal instrument for this particular operation, but it does possess such features as speed and safety, which, of course, make it temporarily acceptable. When mechanical facilities and materials will again be available, I hope to design an instrument that will eliminate the bulk of the power unit from the working end.

On the saw used is an adjustable rest or guide which straddles the saw blade and can be set to conform with the width of the ramus. This must be held firmly against the anterior border of the ramus before the saw can be activated and kept in tight contact during the sawing procedure. This pressure of the guide against the anterior border of the ramus prevents the ramus from moving back and forth with each stroke of the saw. The saw makes about 10,000 strokes per minute. Injury to the soft tissues is remote; for, as soon as the bony parts are sawed through, the firm contact of the rest against the anterior border of the ramus is no longer possible and the tissues with which the saw comes in contact move with the saw. Under this condition, the saw does not cut.

As soon as division is accomplished on one side, a mixture of equal parts of sulfanilamide and sulfathiazole is inserted in the wound, and it is closed immediately. The procedure is then repeated on the opposite side. When both sides are divided and the wounds closed, the mandible is manually manipulated into its predetermined occlusal relation. In this position, it is maintained by intermaxillary fixation, the devices attached to the teeth having been previously installed in both the mandibular and the maxillary arch.

Immediately after the operation, the patients receive 1 gm. of sulfathiazole or sulfadiazine every four hours for forty-eight hours day and night. When this method is employed and the lesion is closed immediately without installation of a drain, the postoperative course is usually uneventful. Patients have experienced a minimum amount of postoperative pain and there has been moderate swelling. All of the patients have expressed their gratitude over the absence of extreme postoperative discomfort and the moderate amount of postoperative bleeding.

It is suggested that if there is evidence of excessive exudation of fluid and distention of the wound, instead of draining the wound intra-orally, a stab wound be made extra-orally under the inferior border of the mandible at a point midway between the anterior and the posterior border of the ramus. A hemostat can then be inserted in the stab wound, and a blunt dissection through the muscle up to the space just below the division of the ramus will permit the evacuation of residual fluid. A quarter inch rubber tube can then be installed as a drain. This should be done as soon as there is any evidence of excess accumulation of fluids, sepsis or abscess formation. One should not wait for distention of the tissues or retention of pus in this

region before instituting this procedure. Early diagnosis to determine the necessity for such a procedure is of the utmost importance.

The use of the sulfonamides or penicillin when such symptoms occur may abort an abscess. In cases devoid of postoperative sequelae, the jaws should be immobilized for a minimum of eight weeks. After this primary immobilization, rubber band traction should be maintained on the anterior portion of the arch for several weeks in the early period of mastication, during which period the patient may train himself to use the jaws in their new anatomic position.

There is usually a tendency for the bite to open after primary closure at the time of operation. If this occurs, the intermaxillary immobilization appliance should be augmented by a chin-cup and headcap joined by rubber bands for continuous traction.

These operations can be performed satisfactorily under mandibular injection anesthesia augmented by infiltration in the region back of the inferior alveolar canal, and additional infiltration on the external surface of the ramus.

When the mandible is moved posteriorly, lack of contact between the posterior portion of the ramus below the division and the superior portion of the ascending ramus constitutes a desirable discrepancy, helping to develop the angular appearance of the face, which before the operation presents an extremely obtuse angle. An optimum angle at which to divide the rami is on a parallel with the occlusal plane of the molar teeth. The final angle of repose of the superior fragments is determined by the activity and angles of traction of the muscles attached to them. The only control that the surgeon has of these parts is that constituted in the establishment and maintenance of the occlusal relation of the mandibular teeth in contact with those of the maxilla. The patient who had little or no occlusal function before the operation experiences little difficulty in becoming accustomed to the new occlusal relation. A short training period enables him to masticate in a satisfactory manner.

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William Harvey established for us a tradition that clinical science shall not be confined narrowly or by artificial boundaries, but shall be free to search how and where it will; a tradition which will not countenance attempts to separate the study of health from that of disease, or the study of animals from that of man, or work at the bedside from that of laboratories.—William J. Carson, in *Quarterly of the American Interprofessional Institute,* Winter 1943-1944.

# AVOIDANCE OF SEVERE ANOXIA IN NITROUS OXIDE ANESTHESIA

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Four types of anoxia are recognized: (1) anoxic, (2) anemic, (3) stagnant and (4) histotoxic.

One or another of these forms of anoxia, or lack of essential oxygen, may occur with any anesthetic agent in use today, including spinal. Van Liere[1] says:

The following produce histotoxic type of anoxia: the barbiturates; bromides; chloral; ether; chloroform; ethylene; cyclopropane, and to a lesser extent carbon monoxide. Nitrous oxide produces the anoxic type and carbon monoxide the anemic type plus the histotoxic to a lesser degree.

Severe anoxia may accompany the use of any anesthetic agent improperly administered, a fact that has not received the publicity given the use of nitrous oxide. That anoxia may occur with improper administration of any anesthetic is shown by Courville.[2] Schnedorf, Lorhan and Orr[3] and Nielson and Friedman[4] describe injury to the cerebral cortex following spinal anesthesia. Steegman[5] reports four cases of prolonged anoxia with resulting brain damage, two following nitrous oxide anesthesia, one with avertin (tribromoethanol) and one with cyclopropane. The term asphyxia is frequently very loosely applied. It implies a decrease in oxygen intake plus obstruction to or a decrease in carbon dioxide elimination. Asphyxia occurs in violent death by strangulation or drowning. In anesthesia, the chief contributing factor is obstruction of the airway.

Improper administration of nitrous oxide, like that of any other anesthetic agent, may cause severe anoxia, affecting the cerebral cortex. The effects are:

1. Temporary brain injury. The patient recovers from the anoxemic effect of the nitrous oxide within from several hours to several days, and shows no residual effect upon the cortex.

2. Slight residual brain injury. The cerebral damage is more severe

1. Van Liere, E. J.: Anoxia: Effect on Body. University of Chicago Press, 1942, p. 168.

2. Courville, C. B.: Ether Anesthesia and Cerebral Anoxia; Study of Causative Anesthetic Complications. Anesthesiology 2:44, January 1941.

3. Schnedorf, J. G.; Lorhan, P. H., and Orr, T. G.: Problems of Anoxia in Surgery and Anesthesia; Report of Experimental and Clinical Cases and Review of Literature. Arch. Surg. 43:169, August 1941.

4. Nielson, J. M., and Friedman, A. P.: Psychomotor Hyperkinesis Due to Anoxia. Bull. Los Angeles Neurol. Soc. 7:202, December 1942.

5. Steegman, A. T.: Ancephalopathy Following Anesthesia; Histologic Study of Four Cases. Arch. Neurol. & Psychiat. 41:955, May 1939.

and the symptoms of asphyxia persist for several days. The patient may be incoherent and be completely out of contact with his environment. The fundi may be normal, pupils equal and reflexes depressed, but equal. The patient may ultimately regain consciousness, but have symptoms of definite residual cortical damage, such as impairment of speech or vision or change in mental aspect. Such a patient may never fully recover normal function.

3. Prolonged or permanent brain injury. When the anoxia is severe and prolonged, extensive cerebral damage may result. The patient may linger on from the anoxemia for several days or even weeks. The necrobiotic changes in the cortex are usually reflected in a restless, maniacal type of delirium, followed by alexia, aphasia and the usual manifestations of cortical defect. Marked and persistent muscular spasms and convulsions are evident, until the patient becomes comatose. Brain degeneration becomes progressive until it is incompatible with life.

4. Death due to asphyxia. Although, in many instances of sudden death under nitrous oxide, some contributory factors can be found, there are cases in which death is due to asphyxia. Such deaths may occur in the alcoholic and resistant patient when the nitrous oxide is forced in spite of warning symptoms of severe anoxia. These patients usually pass very rapidly from the excitement stage into complete respiratory failure. The anemic and debilitated patient, if anesthesia is carried too deep, may die without showing any muscular spasm or similar manifestations of deep narcosis. In the case of sudden death under nitrous oxide, necropsy will show nothing, and it is doubtful whether microscopic examination of the brain would show anything. Degeneration of the cerebral cortex occurs only with prolonged deep anesthesia, whether ether, ethylene, cyclopropane, spinal or nitrous oxide.

### TREATMENT OF ANOXEMIA

Time is the essence of the treatment of severe anoxia. Oxygen under pressure must be administered as soon as possible. The airway must be clear and open. The mouth pack, blood and saliva must be removed and the chin elevated. Artificial respiration with oxygen under pressure must be instituted at the rate of twelve respirations to the minute. Three seconds is devoted to forcing oxygen under pressure, using the face inhaler, and two seconds to pressure upon the lower ribs, forcing the air out of the lungs. The head should be lowered with the patient in the horizontal position. Shock, if present, should be treated. A plasma transfusion should be given early and frequently and the patient should be kept warm.

### MANAGEMENT OF DELIRIUM

In severe cerebral anemia, the delirium is severe and hard to control. Morphine and barbiturates may do more harm than good. Paraldehyde seems to be most effective. Restraint is necessary to prevent physical exhaus-

tion. Supportive measures are necessary and important. Tube feeding must be resorted to, to provide nutrition.

### SAFETY OF ANESTHETIC AGENTS

No anesthetic agent or method is 100 per cent safe. No anesthetic agent is any safer than the ministrations of the anesthetist. Any anesthetic agent can be death dealing in the hands of the ignorant and inexperienced. Thus, an agent ordinarily safe may become deadly owing to maladministration. When trouble occurs with nitrous oxide, and it does sometimes occur with any anesthetic agent, the danger signals are always flying, provided the anesthetist is alert and capable of interpreting them. The human tendency is to shift the blame to the agent or the apparatus rather than to the operator or administrator.

Nitrous oxide is the safest of all anesthetics, if properly administered, for while it has anesthetic properties, it is innocuous to the tissues and to the vital centers of respiration and circulation. It is carried solely in solution in the blood. It does not decompose in the body, and its chemical affinity for other compounds is practically nil. Its rate of absorption and elimination is extremely rapid. No other drug leaves the body so rapidly. It is the only inhalation agent that has no depressing or toxic action on any of the organs of the body. It is the only inhalation agent that can be used with an oxygen deficiency, because it does not depress the protective mechanism of the body. Apart from depressing levels of hypoxia (anoxia), there are no absolute contraindications for its use. Anoxia can and should be avoided in gas-oxygen anesthesia.

No anesthetic can be administered according to predetermined nitrous oxide-oxygen percentages. Some patients will do well on a mixture of 10 per cent oxygen; other patients will require 80 per cent oxygen in the anesthetic mixture. The amount of oxygen required can be determined only by observing the symptoms. The overstimulated athletic and alcoholic patient will require much less oxygen than the anemic and debilitated type. The amount of oxygen in the anesthetic also depends on the pressure under which the gases are administered and on the efficiency of the mouth pack. If inhalation of air is allowed from either lack of pressure or use of an inefficient mouth pack, less oxygen will be needed in the mixture. The percentage of oxygen in the nitrous oxide mixture depends a good deal on the anesthetist. The well-trained dental anesthetist who pays close attention to the airway, mouth pack and symptoms will administer a higher percentage of oxygen in the anesthetic than the inexperienced anesthetist will. The duration of anesthesia is also important. The longer the patient is kept under anesthesia, the greater the amount of oxygen needed in the anesthetic mixture. This applies especially to overstimulated types who take little oxygen in an anesthesia of short duration.

Those who assert that nitrous oxide cannot be administered without

producing a state of cellular asphyxia simply do not know nitrous oxide anesthesia, and are ignorant of the fundamental principles of its administration.

### METHOD OF ADMINISTRATION

Rapid induction is employed in my office. The patient is started on pure nitrous oxide and 10 or more per cent oxygen is added as soon as the first symptom of anesthesia is noted: i.e., change in breathing, loss of lid or lash reflex, eccentric fixation of the eyeball, etc. More oxygen is added soon, the amount depending on the symptoms. The maximum

TABLE 1.—PERCENTAGES OF OXYGEN AT WHICH CASES WERE "LEVELED OFF"

| Cases | Per Cent | Cases | Per Cent |
|---|---|---|---|
| 78 | 5 | 354 | 50 |
| 305 | 10 | 91 | 55 |
| 330 | 15 | 242 | 60 |
| 450 | 20 | 49 | 65 |
| 455 | 25 | 151 | 70 |
| 456 | 30 | 205 | 75 |
| 152 | 35 | 89 | 80 |
| 509 | 40 | 22 | 85 |
| 78 | 45 | 19 | 90 |

TABLE 2.—PERCENTAGES OF PATIENTS AND PROPORTIONS OF OXYGEN AND NITROUS OXIDE REQUIRED FOR ANESTHESIA

| Patients Per Cent | Oxygen Per Cent | Nitrous Oxide Per Cent | Patients Per Cent | Oxygen Per Cent | Nitrous Oxide Per Cent |
|---|---|---|---|---|---|
| 1.94 | 5 | 95 | 8.78 | 50 | 50 |
| 7.56 | 10 | 90 | 2.25 | 55 | 45 |
| 8.19 | 15 | 85 | 5.99 | 60 | 40 |
| 11.12 | 20 | 80 | 1.22 | 65 | 35 |
| 11.28 | 25 | 75 | 3.74 | 70 | 30 |
| 11.31 | 30 | 70 | 5.08 | 75 | 25 |
| 3.76 | 35 | 65 | 2.21 | 80 | 20 |
| 12.62 | 40 | 60 | 0.53 | 85 | 15 |
| 1.94 | 45 | 55 | 0.48 | 90 | 10 |

oxygen tolerated by the patient is administered throughout anesthesia. If the patient shows signs of being too lightly anesthetized, the oxygen percentage is reduced.

Most patients can tolerate a surprisingly high percentage of oxygen with the nitrous oxide. The old dictum as to administering 7 per cent oxygen and 93 per cent nitrous oxide does not hold good with the vast majority of patients. A record of the oxygen percentage is being kept with every anesthetic administered in the office. Data on a survey of the past 4,035 administrations are shown in Tables 1 and 2.

It is the purpose of this investigation to prove that nitrous oxide-oxygen anesthesia can be administered without cellular asphyxia.

At the office, more than 750 anesthetics are administered monthly. The nitrous oxide is administered by three nurse anesthetists and a dentist who is a qualified anesthetist. The results, therefore, are more varied and present a truer picture than if only expert anesthetists were employed. Each anesthetist recorded his or her findings on the patient's chart as well as on a record sheet, and the data were compiled from these record sheets. Premedication was not used, in order to eliminate the effect of a synergist.

The type of operation varied from simple extraction to removal of teeth in multiple impaction, cyst removal and other routine procedures. As the removal of two or more impacted teeth under nitrous oxide-oxygen is a routine procedure at the office, the length of anesthesia varied. The patients were not selected, but were taken as they came. Some gave histories of cardiovascular diseases; others were known alcoholics.

The data presented show that 82.31 per cent of the patients required 20 per cent or more in the anesthetic mixture. Thus, 82.31 per cent of the patients take in the anesthetic mixture as much oxygen as or more oxygen than is in the air. Nitrous oxide can be definitely administered without cellular asphyxia. Those few patients who had to be kept on low oxygen percentages seemed to tolerate the oxygen deficiency well. Aged and debilitated patients require very high oxygen percentages, whereas the overstimulated types seem to do well on low oxygen percentages in anesthesia of short duration.

A great deal has recently been written on the danger of cyanosis and anoxia from nitrous oxide anesthesia, some even advocating that it be prohibited. The presence of cyanosis is not in itself a criterion of the degree of hypoxemia present. It is an established fact that, in nitrous oxide anesthesia, cyanosis is not always a sign of danger; nor is its absence an indication of safety. This is especially true in the plethoric and the anemic. The former may show a moderate degree of cyanosis and yet be lightly anesthetized, while the latter may remain pink, even though a severe degree of hypoxia is allowed to develop.

Nitrous oxide-oxygen anesthesia can be administered without producing a dangerous degree of hypoxia (anoxia).

In oral surgery, nitrous oxide anesthesia can be administered to more than 80 per cent of patients with an oxygen percentage of 20 and more. In some patients, it is necessary to restrict the oxygen intake to 10 per cent or less, thus producing some degree of hypoxia. These patients are tolerant of oxygen want, and the hypoxia need not be allowed to reach a depressing level.

The anesthetist must be familiar with the signs and symptoms of nitrous oxide-oxygen anesthesia, thus avoiding the dangerous levels of hypoxia. The danger in nitrous oxide-oxygen anesthesia is in maladministration and not

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in use. Nitrous oxide anesthesia becomes dangerous only when a severe degree of hypoxia is maintained for a considerable time, thus depressing the respiratory center or injuring the sensitive brain cells. The same holds true with any anesthetic agent.

Clement[6] writes:

It is often stressed that the cyanosis and anoxia (hypoxia) associated with nitrous oxide plus oxygen anesthesia are unphysiological factors. Such is undoubtedly true, but after all is not the state of anesthesia itself unphysiological? It might be said that it becomes a question of drowning the patient with ether, asphyxiating with nitrous oxide, poisoning with cyclopropane, or paralyzing with spinal. Probably our entire approach to anesthesia is wrong. Our present methods consist of using a poisonous drug to keep the patient unconscious and relaxed, during which time we hope its toxic effects will stop short of knocking out the vital functions.

Nitrous oxide is still the safest and least toxic anesthetic agent. Six million six hundred thousand annual world wide administrations during the past forty years prove it to be so.[7]

57 West Fifty-Seventh Street.

6. Clement, F. W.: Anesthesia. Philadelphia: Lea & Febiger, 1945.
7. Dittrick, H.: Horace Wells Discovery. J. of Anes. & Anal. 23:263, November-December 1944.

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In any research activity, the prime factor is the man—the thinker who possesses mastery of his field of learning, vision, patience, and industry. However, the best of men is in a futile position when he is deprived of time, for research is not only a time-consuming activity in itself, but it must be preceded and accompanied by thinking. This thinking can seldom be done upon a scheduled basis; it requires leisure time, for it is a by-product of the musings of imaginative, alert, and competent individuals.—*Report of the Advisory Committee on the Organization of Research, University of Minnesota.*

# UNERUPTED SUPERNUMERARY MANDIBULAR BICUSPIDS: REPORT OF CASE*

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A soldier, reporting for possible oral foci of infection, showed, on roentgenographic examination, three unerupted supernumerary bicuspids, two on the left side (Fig. 1*a*) and one on the right (Fig. 2*a*). All three showed enlargement of the enamel organs; i.e., early dentigerous cysts involving the roots of the adjacent teeth, especially on the left side. The crowns of the permanent bicuspids were negative except for incipient proximal caries. The supernumerary tooth on the right side was palpable through the lingual mucosa, but on the left side there was no evidence of deformity. It was evident that, in due time, the pressure from the enlarging cysts or the unerupted teeth themselves would cause enough resorption to involve the pulps of the adjacent teeth and to result in their eventual loss. Treatment seemed mandatory.

Two plans of treatment were given careful consideration. One was to extract the bicuspids and then remove the upper portions of the enamel organs of the unerupted teeth and await their eruption into position. In case they failed to erupt or were extremely slow, orthodontic aid would be necessary. Also, should the teeth assume their proper positions, there still remained the possibility of developmental defects, insufficient size or abnormal shape. Because of these uncertainties, plus the length of time that might be required, it was decided that the other plan, namely surgical removal of the supernumerary teeth, retaining the permanent teeth, would be the better procedure.

## SURGICAL TECHNIC

Operation on the right side (Fig. 2*a*) was undertaken first because it appeared less difficult. Procaine block anesthesia was used. A horizontal incision about 1.5 cm. long and curving down anteriorly was made through the lingual mucosa to the bone at approximately the upper level of the cystic cavity. The mucoperiosteal flap was elevated carefully to avoid contusion and tearing. The overlying bone was thin and was easily removed with sharp curets. The rough edges were enlarged and beveled smooth by means of surgical burs under constant irrigation with water. The crown of the tooth, which was in mesiolingual version, was carefully exposed. With small curets, the tooth was displaced bodily and removed. The sac was attached to the neck of the tooth as it was removed, this obviating further instrumentation in the cavity. A good blood clot filled the defect. The flap was replaced and sutured.

The left side (Fig. 1*a*) was operated on one month later. The teeth, being more centrally located, were much more difficult to remove in that removal of an excess of bone and involvement of the roots of the adjacent teeth were to be avoided. A longer incision was made on the lingual side, but otherwise as described for the right side. Since there was no deformity to serve as a

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landmark, the location for the openings was determined by estimation and measurement of the x-ray pictures. The openings were made with pointed surgical burs that "dropped" into the cystic spaces, which gave assurance that the location was correct. The openings were then enlarged as described before. When the crowns were exposed sufficiently, an attempt was made to drill a hole into each for the purpose of sectioning the teeth. This proved to be impossible because the tongue retractor and the teeth on the opposite side limited vision and operative approach to a too acute angle. Therefore, it was decided to raise a flap on the buccal side similar to the one on the lingual. Small openings

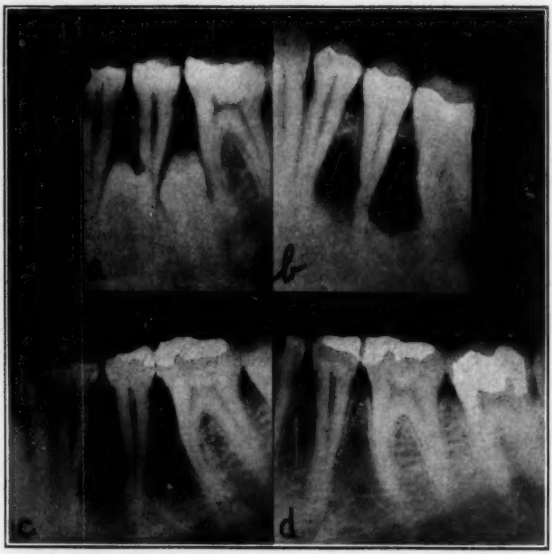


Fig. 1.—*a*, preoperative view of left bicuspid region. *b*, condition four months after operation. *c*, condition eight months after operation. *d*, condition eighteen months after operation. Healing is complete.

were made directly over the crowns of the embedded teeth and then enlarged. Access being excellent on the buccal side, it was possible to drill a hole at right angles into the neck of each supernumerary tooth. With a cross-cut fissure bur, "slots" were cut at right angles to the long axes of the teeth, flaring out lingually to avoid cutting into the adjacent roots. A Crane elevator was placed firmly in each slot and twisted slightly to fracture off the coronal portion of each tooth. The crowns were then tapped through the lingual opening and removed. Small holes were made in the buccal sides of the remaining roots to receive the point of a Cryer elevator, which was used to elevate them out through the lingual openings. The remnants of the sac were carefully enucleated with small curets. The flaps were sutured into position.

Postoperative treatment consisted in the use of ice bags to the jaw and frequent irrigation of the mouth with hot water after the first twenty-four hours.

Little swelling or pain resulted. The soft tissues healed by first intention. The adjacent teeth which showed proximal caries were restored with alloy fillings about a month later.

Four months after operation, an x-ray examination of each area (Figs. 1*b* and 2*b*) revealed only slight bone regeneration. The patient was discharged from the hospital at this time to return to duty.

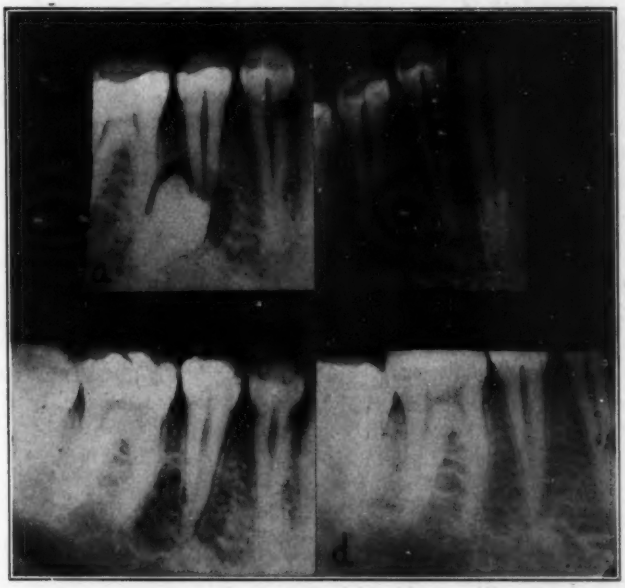

Fig. 2.—*a*, preoperative view of right bicuspid region. *b*, condition four months after operation. *c*, condition eight months after operation. *d*, condition eighteen months after operation. Healing is complete.

Through the cooperation of others, it has been possible to follow the case. After eight months (Figs. 1*c* and 2*c*), the lamina dura was resuming a normal appearance and there was definite bone regeneration. After eighteen months, x-ray examination of each area (Figs. 1*d* and 2*d*) showed almost complete calcification.

## CONCLUSIONS

This case was of interest because of the excellent bone regeneration in the defects and the fact that the peridental structures of the adjacent teeth healed well.

Factors in the success of the case were: (1) avoidance of surgical involvement of the adjacent roots; (2) careful surgical handling of the soft tissues; (3) tooth division; (4) minimum and careful bone removal, and (5) the absence of infection, which is largely dependent on the other factors.

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# OBSERVATIONS ON THE DEFINITIVE TREATMENT OF MAXILLOFACIAL INJURIES*

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In examining and reviewing a large number of maxillofacial gunshot injuries or injuries from contact with high explosive missiles in the military hospitals designated as plastic-maxillofacial centers, one recognizes certain definite facts. The first observation is in great contrast to the observation of World War I in that the incidence of infection of the soft tissues and the bone is much lower. Two or three months after injury, we find comparatively few cases of osteomyelitis or necrosis involving the bones of the face and jaws. This is unquestionably the result of early intelligent treatment in the forward areas. The training of medical and dental officers in maxillofacial surgery, and the assignment of these officers to teams working with the auxiliary surgical groups, have certainly borne fruit in the better condition of the wounds when these patients have been evacuated to the United States for intermediate or definitive treatment.

The second observation is that there has been a much more intelligent effort to stabilize the bones of the face and jaws in a more nearly normal, anatomic relationship. This has aided in avoiding the deformities resulting from collapse of the bony supporting structures of the face, often difficult to overcome in the definitive treatment. Wiring technics have been accepted as an aid in primary treatment in the overseas theaters. We have profited by the experience of the British in the use of sectional cast splints in the intermediate and definitive stabilization of ununited fragments of fractured mandibles. Many of our dental officers have had an opportunity to visit East Grinstead in England while on duty in the European Theater of Operations and have seen much of value in splint technics.

Another observation is the apparent confidence of these patients that they will be restored to a more nearly normal appearance. This is partly due to the fact that many of these patients are sent to hospitals equipped to deal with their deformities and where they come in contact with others having similar deformities, which they have seen improved. This restores their confidence in the ultimate results.

In the maxillofacial patients present months after the original injury, there is a greater need for close cooperation of the plastic surgeon and the dentally trained maxillofacial or oral surgeon. Many of these patients have suffered loss of teeth, bone and soft parts of the face, with cicatricial

*The opinions and views set forth in this article are those of the writer and are not to be considered as reflecting the policies of the War Department (Medical Department of the United States Army).

deformities on the outside of the face and within the mouth. Functional use of the muscles of the face, eyes and jaws must be restored as nearly as possible. The use of the jaws and restoration of the teeth to masticatory function should be taken care of, and the contours of the face should be restored.

The medical officer has learned that the dentist is essential to the ultimate treatment of the maxillofacial injury, just as the dentist realizes that the plastic surgeon is essential to completion of many of the oral operations and the cases as a whole. Mutual understanding as to the part that each should play, and a knowledge of the ultimate requirements in function and appearance, have made the plastic-maxillofacial services function to the ultimate advantage of the patient.

In loss of the lower lip and chin, it is essential to close the defect as early as possible because of the great loss of fluids from drooling of saliva, which has a tendency to dehydrate the patient, as well as the inconvenience of constant drooling on the patient's clothing. It is interesting to note that frequently much of the tissue of the lip and chin can be located in the cicatrices or is found to be rolled into the mouth and adherent to the mucous membrane. This tissue, if it can be freed and uncurled or rotated by flaps, can often be utilized for early closure of the lower lip. When there is a loss of bone in the mandible, an adequate soft tissue bed, in which a bone graft will eventually be placed, is essential. An attempt to insert a bone graft in tense adherent cicatricial tissue will often result in failure. Such tissue should be replaced by tissue having a good circulatory bed and loose enough to accommodate a graft without pressure great enough to alter its contour. Bony support sufficient to withstand masticatory pressure or to aid in retention of a prosthetic appliance is desirable before much of the flat surface plastic repair of the face is complete. Bone grafts in areas communicating with the mouth or in which residual infection persists in the bed or adjoining lost bone are of course doomed to failure, although, with penicillin therapy, some of the implanted bone cells may eventually survive.

Sufficient time should elapse between clearing up of all local infection in the area to be grafted and attempts at grafting. Usually, it is advisable to wait as long as six months before going ahead with the bone graft. Here again the use of penicillin at the time of grafting has reduced the period of waiting formerly considered necessary. The portions of bone to be connected by a graft should be held as rigid as possible if a solid piece of bone is being grafted. Here, the dentally trained surgeon is invaluable in designing, and supervising the splinting of, the parts. The choice of the donor area for mandibular bone grafts varies with the experience of the operator. Most men experienced in this type of surgical work prefer to take the bone from the crest of the ilium. Rib grafts, successfully used by some surgeons, are in the minority. Some of the British maxillofacial surgeons have been using chip grafts taken from the ilium and their results have been excellent. It

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seems that chip grafts would be more applicable to areas where there is a desire to fill in defects in the skeletal structure than to areas which are to stand stress. In most onlay bone grafts of the mandible, the donor graft can be held in place with fine stainless steel or tantalum wire inserted through holes drilled in the bone. In areas where there is not much strain, catgut sutures can be used if the covering soft tissue is sutured so that it makes firm retentive pressure on the bone graft. Most men have used wire for bone graft retention with satisfactory results. It is seldom deemed necessary to open up the area and remove the wire if the ends have been carefully bent and turned in so that there is no irritation of the overlying soft tissue.

Where loss of large portions of one side of the mandible has occurred, it is particularly desirable that the remaining bone on the opposite side be prevented from shifting to the affected side by muscle pull or contraction of the soft tissues. It takes considerable ingenuity to prevent this deformity. It is here that the dental member of a maxillofacial team can serve to great advantage. If some remaining teeth are available, a splint can usually be devised to hold the fragment in place, either by mandibular maxillary fixation or by the use of buccal flanges on a lower splint, which prevents the jaw from shifting laterally to the affected side. Frequently, a splint can be used as the base or support for the attachment of an extension arm to engage a short section of the ramus of the mandible, for the purpose of holding the fragment and preventing it from being drawn upward by the masseter or temporal muscles. Where no teeth are present, a more difficult problem of bone stabilization during a stage of bone regeneration or bone grafting arises. External skeletal fixation appliances may often be the answer to the mechanics of fixation. Otherwise, traction wires attached to bone fragments and stabilized by extension arms from fixed head appliances might be the temporary answer to limited periods of fixation.

Plastic surgery of the skin surfaces of the face has made great advances in the hands of the trained plastic surgeon. The Z plastic operation has elongated many contracting approximation scars and has broken up the lines of scar and made the skin more flexible. Many large defects of the face can be corrected by skin or rotating flaps advancing by successive stages. Skin from the neck can be advanced upward several inches over a period of time to close or cover defects. This is a great advantage because such skin rarely becomes pigmented, having the color and consistency of other facial skin. Tube pedicle flaps from the chest or abdomen are not a good color for the face and should be avoided when it is possible. A tube pedicle flap employing skin from the back of the neck has appeared to have an acceptable color for use on the face. All skin flaps which communicate with the mouth or nostrils must be lined by epithelium, either by doubling the flap on itself or skin grafting a lining to the flap before transposing it into position. Skin losses or contractions about the eyelids can be obtained from the other eyelids, from behind the ear or from the supraclavicular region.

One of the most difficult problems attending the definitive treatment of maxillofacial injuries caused by penetrating missiles is the trismus resulting from the wounds adjacent to the coronoid-zygomatic-temporal area. The marked destruction of the temporal and masseter muscles, as well as the buccinator muscle, results in a dense fibrosis in this area, which either limits or obliterates altogether the masticatory function of the mandible. Attention should be given both to preventing the maximum fibrosis and to correcting functional disability. A close study of these conditions has revealed that the following conditions may be present: 1. A depressed fracture of the zygoma may impinge on the coronoid process of the mandible. 2. A fracture of the coronoid process may impinge against the tuberosity of the maxillae. 3. A fracture of the condyle may be displaced against the zygoma or the temporal bone. 4. The displaced fragments of bone may be buried or incorporated in the masseter, temporal or buccinator muscles, forming a bony bridge between maxilla, mandible, zygoma and temporal bones. 5. Contraction of scar tissue may displace the belly of elevator muscles of mastication. 6. Calcification of the elevator muscles may result from osteogenesis of displaced bone cells. All of these conditions have been encountered in the examination of hundreds of lateral face injuries.

Adequate roentgenographic studies should of course be preliminary to any therapy. Many lateral plates taken of these injured areas are of questionable service because of lack of detail due to superimposition of other bony structures. Pictures in the Waters position, as well as stereoscopic pictures, are often helpful in the region of the temporomandibular joint. Postero-anterior pictures, as well as pictures to delineate the zygomatic arches, are a necessity in these cases.

The treatment of these elevator trismus cases, as well as of the true bony ankylosis in and about the temporomandibular area, presents many complex problems. Roentgenotherapy has offered slight help by reducing fibrosis. Early exercise and moderate spring stretching have aided in some of the simpler cases. Forcible stretching under anesthesia has not only been of no benefit, but also has often done harm by tearing connective tissue bands and causing hemorrhage and inflammation, which result in increased fibrosis.

In a true bony ankylosis, this bony bridge should of course be removed in such a way that further apposition of the bony area would be prevented, by interposing connective tissue or by mechanically keeping the bones apart by an open-bite technic or by prolonged packing until connective tissue fills in the space between the bones. The tendency is to remove insufficient bone by cutting through bony unions alone. This will usually result in failure. It is better to remove too much bone than too little. The use of tantalum, vitallium and acrylics between the bones to prevent subsequent union has been reported, but its adoption is still in question, because the number of cases is not sufficient for adequate conclusions.

Where there is no bony ankylosis and the functional disability is caused

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by formation of cicatricial tissue, it is generally necessary to remove the cicatrix by dissecting out all scar tissue bands and interposing healthy tissue where possible. In the buccal area, it is often advisable to use advancing or rotating flaps instead of tube pedicle flaps. Care to avoid the facial nerve still in function should, of course, always be observed. Where the cicatrix is confined to the buccal tissues, a Z plastic operation may be the procedure of choice. In the deep cicatrices involving the temporal muscle, it may be necessary to remove the coronoid process and all of the enveloping fibrosis. Some cases require a complete arthroplasty, resecting the entire upper third of the ramus, including the coronoid and condyloid processes.

Many trismus cases are the result of formation of cicatricial bands in the mouth between the mandible and the buccal side of the maxilla. Some surgeons attempt to make horizontal incisions through such bands, hoping, by the use of prosthetic appliances, to overcome the deformity. These are attended by ultimate failure unless an epithelial inlay is interposed in the cut area to increase the height of the tissue. Intra-oral Z plastic operations or V.Y. incisions may aid in treatment for minor intra-oral cicatrices.

Another problem in the definitive treatment of maxillofacial injuries is that of adhesion of the buccal mucous membrane to the alveolar ridge of the mandible or the maxilla, which obliterates partially or entirely the vestibule of the mouth. Such a deformity limits the motion of the lips or the buccal muscles, limited motion of the facial muscles of expression resulting. It also limits the ability of a patient to wear a prosthetic appliance to assist in functional mastication, or for cosmetic use, to improve the contour of the face. Such conditions can be treated only by deep incisions through the adherent cicatrix and the interposition of a split graft over a stent mold held rigidly in position. Here again, it is necessary to have the cooperation of a dentally trained maxillofacial or oral surgeon and a prosthetic technician to devise a splint with attachments to hold the stent and graft in position. The depth to which the epithelial inlay is inserted should be such that it overcorrects the sulcus, thereby allowing for some subsequent contraction of the grafted area. A denture or a prosthetic appliance should be inserted soon after the mold is removed and after a "take" of the skin graft has been observed, in order to minimize contraction.

In many areas of the face, loss of bone has left the overlying soft tissue depressed even though the skin and soft tissue are normal and uninjured. When these areas are due to loss of skeletal structure of the lower part of the maxilla or the upper half of the body of the mandible, the contour can often be restored by the use of an intra-oral prosthetic appliance designed in such a manner that, from within the mouth, it rounds out the depressed soft tissue of the face. If the alteration of contour is below the lower half of the mandible, especially the point of the chin or the lower body of the mandible, an autogenous graft of cartilage or bone can be placed by tun-

neling from below into the region of the defect so that the graft is against the underlying bone. In the upper part of the face, depressed areas can be built out by bone, cartilage or a dermis-fat graft as the severity of the deformity may dictate in the experience of the surgeon.

Infra-orbital depressions can be restored by bone grafts from the ilium or the rib rather than by cartilage. The cartilage has a tendency to move or curl slightly, whereas the bone becomes fixed to the underlying depressed bone. Tantalum has been used to repair such defects, but it has not been used for a long enough period to determine its durability. Some tantalum for correcting the contour of these areas has had to be removed. Where diplopia exists, it may be necessary to put either a cartilage or a bone wedge under the globe of the eye to elevate it, if the bony support has been either depressed or lost.

Paralysis of the seventh cranial nerve may follow injury or the attending surgical treatment of a maxillofacial injury. Cooperation of the neurosurgeon and the physiotherapist is often essential in the treatment of the resulting facial paralysis. Some cases will show regeneration of the nerve. Some are amenable to anastomosis of the severed nerve endings by a neurosurgeon. In those cases that do not respond to treatment, the deformity can be corrected or decreased by insertion of fascial strips under the skin to elevate the sagging muscles that have no innervation. This is particularly true about the lips and angle of the mouth.

After surgical procedures have afforded a maximum benefit to the patient, frequently other forms of therapy may be employed. Physiotherapy can be employed in various forms to aid in the circulation, muscle control and development of the tissues in the area involved. Speech training may aid those with injuries of the lips, tongue and palate. The use of cosmetics in various forms may keep the skin in better condition and sometimes conceal discolorations or color inequalities in repaired areas. All therapy should be directed to restoring the patient to as nearly normal functional and social activity as possible. Anything which will obviate physical and mental embarrassment of the patient in his contacts with the world should be employed. The psychologic approach of the doctors and nurses in the treatment of patients with facial deformities is an important factor in the peace of mind of the patient and his desire to cooperate in the treatment.

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# TREATMENT OF GUNSHOT FRACTURES OF THE MANDIBLE

T. J. Cook,* D.D.S.; H. P. Royster,† M.D., and C. K. Kirby,‡ M.D.

The modern principles of treatment of gunshot fractures of the mandible were established in World War I. During the intervening years, certain technical improvements have been introduced, such as the use of ingenious plastic splints and prostheses, but, in contrast to most other injuries, the basic principles of treatment of gunshot fractures have not changed during the present war. In applying these principles, the surgeons of World War II have been given new and powerful agents with which to combat shock and infection, reduce mortality and shorten convalescence; i.e., plasma and whole blood transfusion and sulfonamide and penicillin therapy. Rapid evacuation now brings the wounded under the care of trained maxillofacial and dental surgeons, often within a few hours after injury. The repair of associated soft tissue injuries by plastic procedures, largely developed during the first World War and since refined in the treatment of civilian injuries, has become highly successful in overcoming functional impairment and minimizing cosmetic defects. As a result, the soldier suffering a gunshot fracture of the mandible during the present war has reasonable assurance of returning to civilian life without being unduly handicapped by his injury.

At this general hospital in India, fifty-four gunshot fractures of the mandible were treated during the North Burma Campaign. These comprised approximately 1.5 per cent of all cases admitted to this hospital.

Since the majority of the patients were Chinese, in whom treatment was necessarily carried to completion before discharge, it was possible to observe all phases of treatment from primary operation a few hours after injury, through the late reconstructive stages of bone grafting and plastic procedures.

## INITIAL TREATMENT

1. *First Aid Measures.*—Institution of first aid measures by medical aid men or other soldiers as soon as possible after injury is of great importance in minimizing shock and saving lives. Special attention must be given to the control of hemorrhage, establishment of an adequate airway and temporary immobilization of the fractured fragments.

Because of the rich circulation of the tissues of the face and extensive

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soft tissue damage, hemorrhage is often severe. In most instances, it may be controlled by a compress and a firm bandage. Compression of the facial artery where it crosses the mandible or compression of the carotid artery against the spinal column at the level of the larynx may be helpful in decreasing blood loss. If bony support for a pressure dressing is lacking because of massive comminution of the facial bones, large bleeding vessels should be ligated as soon as possible. Hemorrhage from the tongue may be temporarily controlled by pressure against the mandible followed by passage of a deep ligature proximally from the bleeding area. Death from hemorrhage usually occurs within a few minutes after injury. Bleeding usually subsides quickly.

Fig. 1.—Left: Gunshot wound of left side of mouth with partial destruction of cheek; five days after injury. Right: Appearance three weeks after delayed primary closure, on nineteenth day after wound was received.

Injury to the bony and muscular supporting tissues may cause loss of muscular control of the tongue, with resulting obstruction of the airway. This may be corrected by passing a suture or safety pin through the tip of the tongue in order to anchor the tongue to the exterior dressing. Obstruction of the airway, if due to swelling of the soft tissue or accumulation of blood in the pharynx, may be relieved by employment of a rubber airway. If the soft tissue swelling is severe, tracheotomy, even without adequate facilities, is often a life-saving procedure.

Preliminary immobilization of the fractured fragments is helpful in reducing shock, keeping the airway patent and preventing recurrent bleeding during evacuation. After hemorrhage has been controlled and provisions for an adequate airway have been made, the fractured frag-

ments of the mandible are gently replaced in approximately their normal position and secured with a four-tailed binder or a Barton bandage.

## SHOCK

Shock attending these injuries is usually severe because of the force of the missile and blood loss. Not infrequently, there is an associated head injury. Therefore, in triage, it is imperative that these patients be given priority for antishock therapy. The marked blood loss which they suffer requires immediate blood replacement in adequate amounts. Blood is always preferable to plasma, but, when it is not available, plasma or fluids can be given intravenously as temporary substitutes. Since administration of large amounts of plasma to anemic patients further

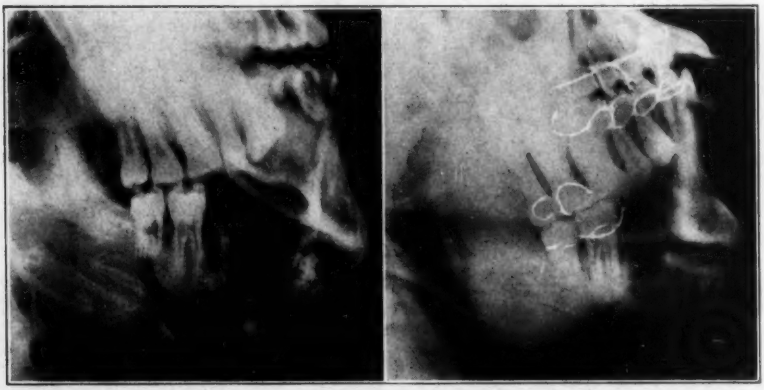

**Fig. 2.—Left: Comminuted gunshot fracture of mandible three days after injury, with clean wound. The tooth root in the line of fracture is to be noted. Right: Bone union eight weeks after wound was received. The fractured tooth had been removed.**

increases anemia by diluting the blood, small supportive amounts of plasma are preferable until whole blood can be given. The present policy of transporting blood to forward areas is undoubtedly of great value in treating these injuries.

## EVACUATION

During the first World War, and also in the present one, it has been found that the position of the patient during evacuation is important. Unless contraindicated by other injuries, the sitting position is to be preferred because it assures decreased bleeding and easier respiration. If the patient is in deep shock or is unconscious, the prone position is necessary, with the face turned to the side, to maintain the airway and prevent aspiration of blood and secretions into the lungs.

PRIMARY OPERATION

Excision of the soft tissue of the face and removal of the comminuted fragments of the mandible in gunshot fracture, in contrast to other gunshot wounds, must be minimal. On the other hand, the soft tissue wound should be sufficiently enlarged to permit free drainage. Excisions of large amounts of tissue of questionable viability may necessitate late plastic reconstruction, whereas removal of minimal amounts permits early and simple cosmetic repair. Bone fragments, unless completely detached from the soft tissue, should not be removed. Because of the excellent blood supply, even moderately large fragments, with only small areas of soft

Fig. 3.—Comminuted gunshot fracture of mandible one month after injury. There is no osteomyelitis. (Compare Figs. 4 and 5.)

tissue attachment, will often survive and aid in bridging the gap between the major fractured fragments. It was formerly considered that all wounds of the oral cavity should be left unsutured and through-and-through drainage be instituted. (Blair,[1] Erich and Austin[2].) The extensive experience of numerous American and British maxillofacial and plastic surgeons has demonstrated that immediate primary closure is indicated in

1. Blair, V. P.: Relation of Early Care to Final Outcome of Major Face Wounds in War Surgery. Mil. Surgeon 92: 12, January 1943.

2. Erich, J. B., and Austin, L. T.: Traumatic Injuries of Facial Bones. Philadelphia: W. B. Saunders Co., 1944.

selected cases when conditions are favorable.[3] This newer concept is accepted by the U. S. Army Medical Department.[4] Primary closure results in quicker recovery and reduces complications and the need for future plastic procedures.

### LOCAL TREATMENT

All wounds involving the oral cavity, with extensive loss of tissue precluding primary closure, soon become extremely foul, chiefly because of infection by anaerobic mouth organisms. Of prime importance is con-

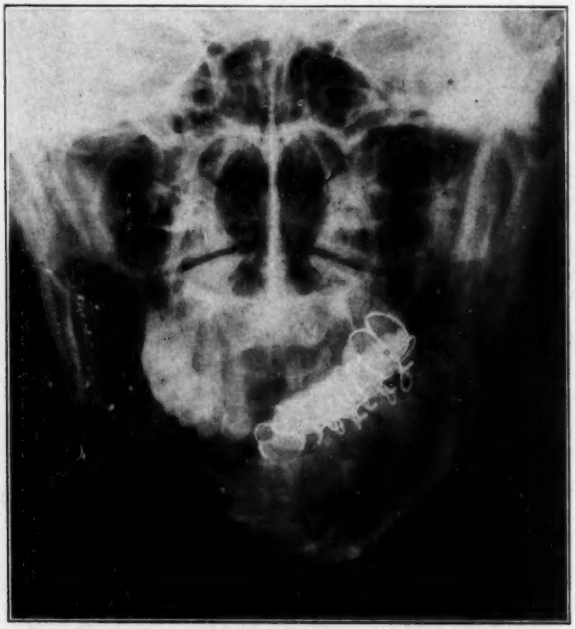

Fig. 4.—Condition of case shown in Figure 3 five months after wound was received. The infected bone had been removed and there was a large defect of the mandible. (Compare Fig. 5.)

stant attention to local cleanliness. Frequent irrigation with a chlorine-liberating solution or with a medicinal suspension of zinc peroxide is the best method. A buret may be hung by the patient's bed and irri-

3. Lawrie, Rex: Primary Closure of Battle Wounds of Face. Lancet 1:626, May 19, 1945.

4. Notes on Care of Battle Casualties. Bull. U.S. Army M. Dept. 4:245-265, September 1945.

gations carried out every two or three hours. Bits of loose bone, dead tissue and exudate should be removed daily.

### SECONDARY OPERATIONS IN WHICH PRIMARY CLOSURE IS IMPOSSIBLE OR NOT UNDERTAKEN

Because of minimal removal of tissue at the primary operation and because of the constant exposure of the wound to virulent mouth organisms, virtually all wounds which enter the oral cavity become grossly infected. Kazanjian[5] has suggested a secondary operation, within from five to ten days after injury, to hasten preparation of the wounds for delayed primary closure. In our experience, this has been a valuable

Fig. 5.—Bone graft in place nine months after injury (case shown in Figures 4 and 5).

procedure. At the secondary operation, demarcation of the necrotic tissue is apparent and excision can be carried out without unnecessarily sacrificing living tissue. Necrotic unattached bone fragments can be recognized and removed. Loose and carious teeth and foreign bodies, revealed by roentgen-ray examination, may be dealt with. At this operation, the surgeon has the opportunity to take all steps necessary to promote prompt, uncomplicated healing when secondary closure is performed.

### DELAYED PRIMARY CLOSURE

The principle of early delayed primary closure of wounds of the face

5. Kazanjian, V. H.: Early Treatment of Gunshot Wounds of Face and Jaws. Surgery 15:22, January 1944.

was established by Kazanjian.[5] An open granulating wound which heals by second intention, while undesirable in any part of the body because of subsequent fibrosis and contraction, is frequently disastrous in wounds of the face. In a wound which appears small and insignificant soon after injury, contraction due to fibrosis often produces marked enlargement of the defect because of the looseness and mobility of the surrounding tissues. In addition, the contraction may cause associated deformities of the nose, mouth and eyelids. Not uncommonly, the size of the defects after contraction requires that tissue for repair be obtained from other parts of the body. In most instances, as Kazanjian[5] has shown, these sequelae due to fibrosis may be prevented by delayed primary closure of the wound, when the tissues are soft and mobile. Late extensive plastic procedures, with introduction of tissue from other parts of the body, may thereby be avoided.

### CHEMOTHERAPY

The use of chemotherapeutic agents has favorably influenced the course of these wounds by limiting the spread of infection in the early stages. This is true both for the sulfonamides and for penicillin. The use of the sulfonamides alone has failed to shorten the course of chronically infected wounds, especially those associated with osteomyelitis. In another report,[6] it was demonstrated that penicillin therapy hastened cure in chronic osteomyelitis of the mandible and soft tissue infections of the face, provided all indicated surgical measures were carried out. Penicillin must be considered a supplementary form of therapy since the infection does not subside unless all sequestra, infected teeth, foreign bodies and abscesses have been properly cared for. Early prophylactic use of penicillin in the chain of evacuation has been proved of great value.

### IMMOBILIZATION

Since establishment of perfect position of the fragments is useless if the patient cannot masticate comfortably, the aim of reduction and immobilization of the fractured mandible is restoration and maintenance of the normal occlusal relationship of the teeth. Preliminary interdental wiring with elastic traction may be accomplished even before the roentgen-ray films are made. As soon as possible, roentgen-ray studies of the entire mandible are obtained and any necessary adjustments or additions to the apparatus are made. Because of the varied picture in mandibular fracture, treatment must be individualized, considering location of the fractures and bone defect and the presence and distribution of teeth. If a sufficient number of teeth are present on each side of the bone gap,

6. Royster, H. P., and Cook, T. J.: Penicillin in Treatment of Oral and Maxillo-Facial Infections. To be published.

interdental wiring with intermaxillary elastic traction is the method of choice. In some cases, immobilization is not required. In others, simple support by a chin strap of molded acrylic, attached by elastics to the four ties of an operating room mask slung over the vertex of the head, will maintain position. The early removal of teeth from the line of fracture is not always indicated. In fracture of the body of the mandible with one tooth remaining in the posterior fragment, temporary retention of this tooth will aid in immobilization. Three or four weeks later, the tooth may be removed. All badly fractured teeth and those impacted in the line of fracture should be removed before the patient is discharged. Dental splints and arch bars are useful in maintaining position when there are gaps due to loss of teeth and bone, and in preserving the dental arch. Numerous methods of immobilization have been described elsewhere for use in special cases.

Elastic traction, or some other means of immobilization, should remain in place until firm union is demonstrated clinically. It is not necessary to wait for roentgen-ray confirmation of bony union, which may not be evident for months. Immobilization in gunshot fractures should be continued for an average of from six to ten weeks. During this period, it is essential that the patient be seen daily by the dental officer to have the mouth cleaned by irrigation and spraying and the appliance adjusted to preserve occlusion. After removal of the traction, further improvement of the bite can be obtained by grinding the teeth to balanced occlusion.

The principle of early soft tissue immobilization has been emphasized by Kazanjian.[7] If there is loss of bone, and if subsequent contraction of the soft tissues takes place before bone grafting can be done, a soft-tissue-supporting prosthesis should be applied. Such an apparatus is inserted within the first few days after injury. When infection has subsided, the soft tissue plastic restoration is performed over the prosthesis, and is followed at an appropriate time by a bone graft or cartilage transplant.

## COMPLICATIONS

1. *Osteomyelitis.*—Osteomyelitis, the most frequent complication in gunshot fracture of the mandible, is the major cause of prolonged convalescence and disability. After wound infection is established, the prevention of osteomyelitis is difficult. It is shown in our series that of twenty-eight wounds which were infected on admission to this hospital, twenty-four developed osteomyelitis. The prevention of this complication is all important, and assiduous treatment as outlined above must be employed if success is to be obtained. Bone infection destroys teeth and living bone fragments, with formation of a larger defect, and retards bony union. Before the era of modern chemotherapeusis, the treatment of osteomye-

7. Kazanjian, V. H.: Internat. J. Orthodontia 6:97, February 1920.

litis agreed on was a conservative program of watchful waiting. This period of waiting lasted for many weeks or months, and the patient was rarely free from a suppurating wound. In recent years, the trend has been toward a radical approach to the problem, and extensive surgical drainage is carried out, both intra-orally and extra-orally, with removal of sequestra, foreign bodies and infected teeth. Radical incision has been necessary even in the absence of sequestra. The large wound created by this incision can be treated later by delayed primary closure. In osteomyelitis without sequestration, penicillin therapy frequently effects a cure. When a radical operation for removal of teeth, sequestra or a foreign body is combined with penicillin therapy, there is little danger of spread of the infection or in its reactivation. One may be extremely radical at operation with assurance that fulminating osteomyelitis and cellulitis will rarely occur.

2. *Delayed Union.*—This complication, in our experience, was not a serious one, and management is not difficult. We have arbitrarily chosen three months as the limit for primary union, since healing in fractures of the mandible, as a rule, is rapid. If there is firm fibrous union and the patient can masticate comfortably, immobilization is no longer needed. It is, therefore, not necessary to await roentgen-ray confirmation of bony union for the removal of traction.

3. *Nonunion.*—Nonunion is usually caused by extensive loss of bone at the time of injury and by osteomyelitis. The sloughing extrusion of bone fragments leaves a defect which may not be bridged; or infection of the bone ends may *per se* prevent union in contiguous fragments. In the absence of bony union, there are usually malocclusion, masticatory dysfunction and marked deformity, with "drift" of the mandible to the affected side. In these instances, bone grafting must be carried out to restore the occlusion and the appearance. In patients whose occlusion and masticatory function are normal despite the bone defect, bone grafting is unnecessary.

Since infection is the chief cause for failure in bone grafting, a period of six months should elapse between the time the wound was free of infection and the time of placing the graft. During this period, the mandibular fragments should be immobilized in normal position with the teeth in occlusion in order to prevent soft tissue contracture and deformity of the fragments. Prophylactic administration of penicillin should be employed to reduce the chance of infection just before and after operation.

Nonunion occurred in seven cases (14 per cent) of our series. In four of these, bone loss at the time of injury was the cause; and in three, osteomyelitis. Three of the patients received grafts; two are awaiting bone graft, and two were discharged from the hospital for reasons other than their facial injuries. The grafts were performed according to the modified technic of Erich and Austin.[2] One was successfully completed with the aid of penicillin given prophylactically. The other two became infected shortly after opera-

tion, and penicillin must be credited with the saving of both. Only a minimal supply of penicillin limited its prophylactic use in all of the cases.

### OTHER COMPLICATIONS

1. *Trismus.*—This may delay return of mandibular function. The common cause is injury to the masseter or temporal muscle and the temporomandibular joint rather than prolonged immobilization, since many cases occur in patients whose jaws have not been in traction. Trismus may be successfully treated by means of an "exerciser" used many times daily by the patient himself.

2. *Parotid Fistula.*—Injuries of the parotid gland or its duct may give rise to external discharge of a parotid salivary secretion. Usually, these lesions heal spontaneously, but occasionally one must be repaired. One unhealed fistula in this series of cases was successfully operated upon by the dowel method of Glascock and Glascock.[8]

3. *Secondary Hemorrhage.*—Secondary hemorrhage occurred in 8.5 per cent of Kazanjian's cases in World War I and was regarded as a major complication. In our series, there were no cases of secondary hemorrhage, nor were any instances found in the recent literature. The reason for this may be the modern supportive measures, chemotherapy, which limits infection, and rapid evacuation of patients by air.

4. *Facial Nerve Palsy.*—Injury to the facial nerve frequently accompanies wounds at the angle of the mandible. The nerve fibers, if identifiable, should never be sutured at the primary operation since infection or scarring may destroy the anastomosis. Ideally, the nerve should be sutured soon after wound healing. If this is not done, the deformity may be corrected by plastic procedures.

### SUMMARY

The essential steps in the treatment of gunshot fractures of the mandible are:

1. First aid measures, consisting of control of hemorrhage, establishment of an adequate airway and temporary immobilization of the fractured bone.
2. Treatment of shock.
3. Minimal primary excision, without suture except when conditions are favorable for primary closure.
4. Early immobilization of the fractured bone.
5. Secondary minimal excision and débridement from five to ten days after the injury, accompanied or followed by delayed primary closure of the skin wound.
6. Prophylactic and therapeutic use of the sulfonamides and penicillin.
7. Treatment of osteomyelitis by early radical operation.

4645 North Bay Road, Miami Beach, Fla.

8. Glascock, H., and Glascock, H., Jr.: Repair of Traumatic Fistulas of Stenson's Duct. Surg., Gynec. & Obst. 65:335, September 1937.

# ACETYLSALICYLIC ACID (ASPIRIN) AS A CAUSE OF BLEEDING

LESTER CAHN, D.D.S., New York, N. Y.

There is nothing more annoying during an intra-oral operation than excessive bleeding. Equally annoying is postoperative oozing or that troublesome type of bleeding following the removal of a gauze packing. In the latter instance, the patient frequently has to be kept in the office biting on a wad of gauze for an indefinite time, delaying other appointments or occupying a dressing room that could well be used for something more important. Often, pressure will not stop the bleeding and the wound has to be repacked, which adds to the discomfort and further delays healing.

The causes of excessive bleeding are many, but an important one is the use of acetylsalicylic acid. This drug, of all home remedies, is probably the one most frequently used. It is an analgesic and is especially useful for pain arising from the teeth.

It has been known for years that administration of acetylsalicylic acid has toxic effects, especially in those having an idiosyncrasy to this drug. Deaths from its administration have been reported. Severe reactions are rare, but there is evidence that ingestion of acetylsalicylic acid and other salicylates does frequently cause physiologic changes in that it brings about in the blood a decrease in prothrombin.* This has been shown in the following observations:

Cattle and other ruminants, when fed spoiled sweet clover hay, develop a hemorrhagic disease characterized by a prolonged clotting time, which was shown by Roderick[2] to be due to a low prothrombin content of the blood. The active toxic principle of the spoiled sweet clover hay, isolated by Campbell and Link,[3] was called dicoumarin. The substance could be

*Prothrombin is a globulin synthesized principally by the liver. The successful production of prothrombin is dependent on the normal amount of absorption of vitamin K and a healthy condition of the liver. Without prothrombin, the blood will not clot. The clotting process can be expressed in the following equation: prothrombin+calcium+thromboplastin=thrombin; thrombin+fibrinogen=fibrin.[1]

1. Cahn, L. R.: Abnormal Bleeding. Ann. Dent. 3:5, June 1944.

2. Roderick, L. M.: Problem in Coagulation of Blood: "Sweet Clover Disease of Cattle." Am. J. Physiol. 96:413, February 1931.

3. Campbell, H. A., and Link, K. P.: Studies on Hemorrhagic Sweet Clover Disease, IV. Isolation and Crystallization of Hemorrhagic Agent. J. Biol. Chem. 138:21, March 1941.



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degraded qualitatively to salicylic acid. Link[4] and his co-workers, trying to determine the effect of administration of salicylic acid on rats on diets deficient in vitamin K, found a decrease in prothrombin. If the salicylic acid was given over a long period, hemorrhage developed. If vitamin K was administered, the prothrombin did not decrease and there was no hemorrhage.

These same results were observed in human beings.[5-6] Salicylate administration caused hypoprothrombinemia, which could be prevented by simultaneous administration of vitamin K. Once excessive bleeding has occurred after the use of salicylates or acetylsalicylic acid, vitamin K is of little use. This vitamin, then, is to be used as a prophylactic.

These experiments and observations explain hemorrhage following eye operations when salicylates had been taken for long periods of time; excessive bleeding occurring after operations in the mouth, and the three cases of recurrent nosebleed reported by an English physician.[7] In one of his cases, that of a child, epistaxis could be produced at will by giving acetylsalicylic acid. Otherwise, there was no evidence of a hemorrhagic tendency. This physician concluded that "aspirin taking being such a universal habit, it is difficult to get a clear idea as to what extent it does produce a hemorrhagic tendency, but it would seem necessary in all cases of obscure hemorrhage to inquire if aspirin has been taken."

All dentists and oral surgeons, in prescribing acetylsalicylic acid, should incorporate vitamin K in their prescriptions.* In a recent conversation with an official of a large drug company, I learned that work is underway to provide acetylsalicylic acid and vitamin K in one tablet. The product is not yet on the market. Until it is, all persons taking the drug should take with

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*Vitamin K, sometimes called the anticoagulation vitamin, is found in egg yolk and green leafy plants, such as alfalfa. It is synthesized by many bacteria, notably the colon bacillus. The body requires very little vitamin K, probably less than 1 mg. daily. Quick[8] says, "It would be exceedingly difficult to supply a diet of natural foods that would not exceed in its vitamin K content this minimal requirement. Furthermore, the intestinal bacteria are constantly synthesizing this substance, probably in amounts sufficient for normal needs."

We have noted that vitamin K is necessary for the production of prothrombin by the liver. If this production is prohibited by administration of acetylsalicylic acid, additional vitamin K must be taken to counteract the inhibitory action of the drug.

4. Link, K. P., et al.: Studies on Hemorrhagic Sweet Clover Disease. J. Biol. Chem. 147:463, February 1943.

5. Meyer, O. O., and Howard, Beryl: Production of Hypoprothrombinemia and Hypocoagulability of Blood with Salicylates. Proc. Soc. Exper. Biol. & Med. 53:234, June 1943.

6. Shapiro, S.; Redish, M. H., and Campbell, H. A.: Studies on Prothrombin, IV. Prothrombinopenic Effect of Salicylate in Man. Proc. Soc. Exper. Biol. & Med. 53:251, June 1943.

7. Honigsberger, M.: Brit. M. J. 2:57, July 10, 1943.

8. Quick, A. J.: Hemorrhagic Diseases. Springfield, Ill.: Charles C. Thomas, 1942.

every 5 grain tablet 1 mg. of vitamin K. In this way, unnecessary bleeding will be prevented.

888 Park Avenue.

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*Pentothal Anesthesia.*—In the May 1944 *Bulletin,* attention was directed to an overseas report on pentothal anesthesia, which brought to light a high death rate attributable to sodium pentothal and pointed to the unwise use of this agent rather than its inadequacy for military purposes. Another report from the same overseas theater has been submitted which compares present experience with that previously recorded and demonstrates the improvement that has been achieved through education in its more rational use. It is stated that a year ago the death rate from pentothal anesthesia was so high that the question was raised of abandoning the agent. However, examination of the deaths that occurred indicated that two correctible factors were present: (1) its use by completely inexperienced individuals, and (2) its use in cases in which it was actually contraindicated. Because of the advantage of the agent in warfare, the decision was made to continue its use, at the same time taking measures to correct these two factors.

The collected data show that whereas the over-all pentothal death rate a year ago was 1 to 450, the present rate is 1 to 5,500. That this great improvement in the anesthesia death rate from pentothal has not come about at the expense of abandoning pentothal is shown by the fact that although a year ago the agent was employed in 53 per cent of the cases, at present it is employed in 62 per cent of the cases in the forward hospitals, and these respective figures for the rear hospitals are 28 and 48 per cent. Thus, despite the fact that the use of pentothal has actually increased over the past year, a great reduction in the anesthesia death rate has occurred, clearly showing how well, through education and experience, its intelligent application has been effected. As previously emphasized, pentothal has proved especially valuable as an anesthetic in military surgery in procedures in which relaxation is not essential, and particularly for short (half-hour) operations and on individuals in good condition. The routine use of atropine as pre-anesthetic medication, the administration of oxygen, and frequent observations of pulse and blood pressure during the anesthesia are considered important factors in the safe use of pentothal. The use of pentothal should be avoided when the operative position or procedure may interfere with the airways or make respiration difficult, as in operations performed in the face-down position and operations on maxillofacial injuries, or infection about the neck, and other conditions involving the airways. Pentothal is also not considered a wise choice in intracranial surgery, in burns, and in conditions in which it is believed liver damage exists.—*Bull. U. S. Army M. Dept.,* February 1945.

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# PAPILLARY CYSTADENOMA LYMPHOMATOSUM (ADENOLYMPHOMA) OF THE PAROTID REGION: REPORT OF CASE*

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The occurrence of papillary cystadenoma about the parotid region may be more frequent than the number of published cases in the literature indicates. Papillary cystadenoma lymphomatosum in this region was first described by Hildebrandt[1] in 1895. Since 1910, when Albrecht and Arzt[2] again drew attention to this particular tumor, publishing a report of two cases, a few case reports have appeared in the literature. In 1932, Jaffé[3] reviewed the literature and added one case, stating that this brought the total of published cases to twenty-two. In 1933, Kraissl and Stout[4] reviewed the literature, citing nineteen cases reported by various authors and adding two cases of their own. They cited several cases not mentioned by Jaffé. In 1935, Carmichael, Davie and Stewart[5] reviewed the literature. In 1938, Freshman and Kurland[6] reviewed the literature and, in 1940, Lederer and Grayzel[7] reviewed the literature. The accompanying table is an attempt at a corrected review of the literature.

Papillary cystadenoma lymphomatosum occurs most commonly in the region of the parotid gland or near the angle of the mandible, but may occur near any of the salivary glands. It is a benign slow-growing encapsulated tumor. It usually affects persons between 45 and 75 years of age, but has been reported in a boy 2½ years of age and a man 92 years old. Grossly, the tumor is ovoid or coarsely lobulated, usually 2 to 6 cm. in diameter, relatively firm to palpation and covered by a thin adherent capsule. It is cut with ease. The cut surface is finely granular and presents numerous small cysts filled with serous or mucinous material. The capsule of the tumor may fuse with the external surface of a salivary gland, but surgical removal usually meets with no difficulty and the tumor does not recur after complete removal.

Microscopically, Jaffé defines the tumor as being composed of tubular glands and small cysts lined by a double layer of cylindrical epithelial cells,

*From the Surgical Service of St. Luke's Hospital.

1. Hildebrandt, O.: Arch. F. Klin. Chir. 49:183, 1895.
2. Albrecht, H., and Arzt, L.: Frankfurt. Ztschr. f. Path. 4:47, 1910.
3. Jaffé, R. H.: Am. J. Cancer 16:1415, November 1932.
4. Kraissl, C. J., and Stout, A. P.: Arch. Surg. 26:485, March 1933.
5. Carmichael, R.; Davie, T. B., and Stewart, M. J.: J. Path. & Bact. 40:601, May 1935.
6. Freshman, A. W., and Kurland, S. K.: Am. J. Clin. Path. 8:422, July 1938.
7. Lederer, M., and Grayzel, D. M.: Arch. Path. 34:833, November 1942.

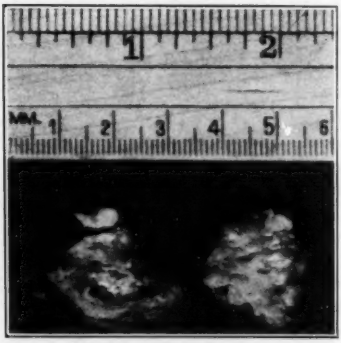


Fig. 1.—Gross specimen.

Fig. 2.—Histologic specimen.

which may be raised to slender and branched papillae. The cells are pale and under low power magnification appear homogeneous. The nuclei stain deeply and are located near the lumen. The space between the glands and cysts is filled with lymphatic tissue, which also forms the core of the papillae. Most of the investigators stress the importance of large germinal centers. The epithelium rests on a thin membrane, which seems to fuse with the argentaffin reticulum of the lymphatic stroma.

Several theories of origin have been proposed. Albrecht and Arzt advanced the hypothesis that these tumors arise from heterotopic salivary glands and show that the acini and ducts of the glands and the lymphadenoid tissue are found in intimate relationship. Nodules of lymphatic tissue form

THE LITERATURE

| | Author | Date | Sex | Age | Location of Tumor |
|---|---|---|---|---|---|
| 1. | Hildebrandt | 1895 | ♂ | 41 | Left angle of jaw in parotid region |
| 2. | Sultan | 1898 | ♂ | 44 | Extending from left ear to masseter muscle |
| 3. | Morestin | 1902 | ♀ | 23 | Right posterior parotid region |
| 4. | Lecene: Case 1 | 1908 | ♀ | 40 | Right parotid region |
| 5. | Lecene: Case 2 | 1908 | ♂ | 50 | Right parotid region |
| 6. | Albrecht & Arzt: Case 1 | 1910 | ♂ | 64 | Left parotid |
| 7. | Albrecht & Arzt: Case 2 | 1910 | ♀ | 12 | Submaxillary |
| 8. | Glass | 1912 | ♂ | 66 | Left angle of mandible |
| 9. | Sobolew: Case 1 | 1912 | ♂ | 54 | Right parotid |
| 10. | Sobolew: No. 2 | 1912 | ♂ | .. | Parotid |
| 11. | Delanglade, Peyron & Rouslairoix | 1914 | ♀ | 23 | Left parotid |
| 12. | Feldman | 1916 | ♂ | 51 | Left angle of mandible |
| 13. | Ehrlicher | 1922 | .. | .. | Parotid |
| 14. | Nicholson: No. 1 | 1923 | ♀ | 60 | Immediately below right parotid |
| 15. | Nicholson: No. 2 | 1923 | ♂ | 50 | Right angle of mandible |
| 16. | Mazza and Cassinelli | 1923 | .. | .. | Left parotid |
| 17. | Menetrier, Peyron & Surmont | 1923 | ♂ | 50 | Parotid |
| 18. | Rihl | 1924 | ♂ | 47 | Right angle of mandible |
| 19. | Askanazy | 1926 | ♂ | 54 | Parotid |
| 20. | Siegmund & Weber | 1926 | .. | .. | .... |
| 21. | Stöhr & Risak | 1926 | ♂ | 2½ | Right parotid |
| 22. | Houdard & Hufnagel | 1927 | .. | 58 | Left parotid |
| 23. | Letulle: No. 1 | 1927 | ♂ | .. | Parotid |
| 24. | Letulle: No. 2 | 1927 | .. | .. | .... |
| 25. | Bottin | 1929 | ♂ | 56 | Parotid |
| 26. | Spitznagel: No. 1 | 1929 | ♂ | 65 | Left parotid |
| 27. | Spitznagel: No. 2 | 1929 | ♂ | 45 | Left parotid |
| 28. | Cunningham | 1929 | ♂ | 16 | Right parotid |
| 29. | Warthin: No. 1 | 1929 | ♂ | 45 | Parotid |
| 30. | Warthin: No. 2 | 1929 | ♂ | 60 | Left parotid |
| 31. | Wendel | 1930 | ♂ | 56 | Right submaxillary |
| 32. | Hanford | 1931 | ♂ | 61 | Left parotid |
| 33. | Brachetto-Brian | 1931 | ♂ | 57 | Right submaxillary |
| 34. | Hamperl | 1931 | ♂ | 70 | Parotid |
| 35. | Jaffé | 1932 | ♂ | 73 | Right parotid |
| 36. | Kraissl & Stout: No. 1 | 1933 | ♂ | 61 | Left angle of jaw |
| 37. | Kraissl & Stout: No. 2 | 1933 | ♀ | 74 | Left parotid |
| 38. | Carmichael, Davie & Stewart: No. 1 | 1935 | ♂ | 63 | Left parotid |
| 39. | Carmichael, Davie & Stewart: No. 2 | 1935 | ♀ | 58 | Right parotid |
| 40. | Carmichael, Davie & Stewart: No. 3 | 1935 | ♂ | 47 | Left parotid |
| 41. | Carmichael, Davie & Stewart: No. 4 | 1935 | ♂ | 58 | Right parotid |
| 42. | Carmichael, Davie & Stewart: No. 5 | 1935 | ♂ | 58 | Left angle of mandible |
| 43. | Carmichael, Davie & Stewart: No. 6 | 1935 | ♂ | 92 | Right angle of mandible |
| 44. | Carmichael, Davie & Stewart: No. 7 | 1935 | ♀ | 66 | Right parotid |

THE LITERATURE—continued

| | Author | Date | Sex | Age | Location of Tumor |
|---|---|---|---|---|---|
| 45. | Carmichael, Davie & Stewart: No. 8 | 1935 | ♂ | 76 | Left parotid |
| 46. | Hall | 1935 | ♂ | 48 | Left parotid |
| 47. | Wood: No. 1 | 1935 | ♂ | 37 | .... |
| 48. | Wood: No. 2 | 1935 | ♂ | 48 | .... |
| 49. | Wood: No. 3 | 1935 | ♂ | 71 | .... |
| 50. | Harris: No. 1 | 1937 | ♂ | 61 | Right parotid gland |
| 51. | Harris: No. 2 | 1937 | ♂ | 62 | Parotid |
| 52. | Freshman & Kurland | 1938 | ♂ | 63 | Edge of left sternocleidomastoid muscle |
| 53. | Swinton & Warren: No. 1 | 1938F | ♂ | 71 | Left parotid |
| 54. | Swinton & Warren: No. 2 | 1938 | ♀ | 53 | Right parotid |
| 55. | Swinton & Warren: No. 3 | 1938 | ♀ | 50 | Left parotid |
| 56. | Swinton & Warren: No. 4 | 1938 | ♀ | 66 | Left parotid |
| 57. | Swinton & Warren: No. 5 | 1938 | ♂ | 61 | Right parotid |
| 58. | Joyce, Menne & Zeller: No. 1 | 1941 | ♂ | 68 | Left angle of jaw |
| 59. | Joyce, Menne & Zeller: No. 2 | 1941 | ♂ | 40 | Left angle of jaw |
| 60. | Lederer & Grayzel: No. 1 | 1942 | ♂ | 66 | Left angle of jaw |
| 61. | Lederer & Grayzel: No. 2 | 1942 | ♀ | 57 | Right angle of mandible |
| 62. | Lederer & Grayzel: No. 3 | 1942 | ♂ | 45 | Left parotid |
| 63. | Lederer & Grayzel: No. 4 | 1942 | ♂ | 54 | Left angle of mandible |

within these glands and, in these formed islands, glandular structures may subsequently appear. In addition to this process, enclosure of areas of glandular tissue may occur in true lymph nodes. Lubarsch pointed out that islands of parotid or submaxillary gland tissue are occasionally found in the lymph nodes about the parotid glands, at the angles of the mouth or in the neck. Warthin[8] and Wendel[9] believe that these growths arise from heterotopic rests of ectodermal cells of the respiratory or eustachian tube anlages. They base these views on the embryologic character of the epithelium, which resembles closely that found in the eustachian tube. Hamperl[10] and Schaffer described a cell which is rarely seen in a salivary gland before the age of 30, but is almost constantly present after the sixth decade, and termed it an oncocyte. Jaffé believed that the epithelial cells of a papillary cystadenoma lymphomatosum correspond in every way with the oncocytes of Hamperl. Because of this, Jaffé proposed the name oncocytoma. Since oncocytes are an evidence of senility and are found only in persons past 20 years of age, this term does not explain the presence of this tumor in one patient of Albrecht and Arzt, who was only 12 years of age, in the patient of Cunningham, who was 16 years old, and in the patient of Stöhr and Risak, who was 2½ years of age. Among the proponents of the theory that the tumor is of branchiogenic origin were Askanazy and Sternbery.

8. Warthin, A. S.: J. Cancer Res. 13:116, July 1929.
9. Wendel, A., Jr.: J. Cancer Res. 14:123, March 1930.
10. Hamperl, H.: Virchow's Arch. f. Path. Anat. 282:724, 1931.

They base their views on the embryonal type of epithelium and on the lymphoid stroma, which is characteristic of branchiogenic cysts.

Kraissl and Stout[4] try to explain the origin of the tumor by what they call an orbital inclusion. During investigations on the development of orbital glands in some species of carnivora, they observed that the adult parotid gland develops from an embryonal sulcus in the oral cavity. They found that earlier investigators had reported tubular structures lined by tall columnar epithelium in the region of the parotid glands, but not connected with these glands. The tubules were felt to be capable, under certain conditions, of developing into cystic structures. With the growth of the embryo, the parotid gland comes to lie in close proximity to the tubular structure, which they named the orbital inclusion. The ultimate fate of this structure in man has never been determined, but it is within the realm of possibility that such a closed vestigial epithelium-lined duct might, under certain conditions, develop into a cystic growth.

## REPORT OF CASE

A practicing physician, aged 58, six months before operation had noted a small nodule directly below the lobe of the right ear near the angle of the mandible. Progressive asymptomatic enlargement occurred until, at the time of operation, a firm oval finely lobulated mass 2-3 cm. in greatest diameter was grossly visible immediately above the right angle of the mandible. Under procaine infiltration anesthesia, the tumor was found to be fused to the posterior capsule of the lower tip of the parotid gland. Surgical extirpation presented no difficulties.

Grossly, the material consisted of a specimen of tissue measuring 20 by 15 by 12 mm., yellowish gray, moderately firm and rather ragged in contour. On sectioning, it showed areas of yellowish gray mottling, which are more characteristic of inspissated pus than they are of tumor tissue; the gross picture being one of a subacute inflammatory lesion rather than of a neoplasm. (Fig. 1.)

Histologically, sections showed lymphoid tissue in which there were many cystic spaces lined by a rather transitional type of epithelium, which, in a few scattered instances, took on a definite tall columnar-like character. The epithelial structures throughout were benign. The tissue between the various spaces was characterized by typical lymph node histologic structure. (Fig. 2.)*

*Additional references pertinent to the text.

11. Cunningham, W. F.: Ann. Surg. 90:114, July 1929.
12. Hanford, J. M.: Ann. Surg. 94:461, September 1931.
13. Harris, P. N.: Am. J. Path. 13:81, January 1937.
14. Wood, P. H.: Am. J. Path. 11:889, September 1935.
15. Swinton, N. W., and Warren, S.: Surg., Gynec. & Obst. 67:424, October 1938.
16. Joyce, T. M.; Menne, F. R., and Zeller, W. E.: Arch. Surg. 42:338, February 1941.

# PENICILLIN IN SUBMANDIBULAR CELLULITIS AND CLINICAL SEPTICEMIA: REPORT OF CASE

EDWARD R. FERRO,* D.D.S., New Orleans, La.

*History.*—A boy, aged 8, colored, seen July 10, 1944, in the emergency room of the Charity Hospital of Louisiana, had had a lower right second deciduous molar extracted two days earlier. The affected tooth had been sore to the touch and the face was slightly swollen and tender at the time of extraction. After removal of the affected tooth, the face became swollen. There was bleeding from the socket for the next forty-eight hours. The patient was referred to the Charity Hospital.

*Clinical Examination.*—There was a large swelling of the right side of the face over the mandibular region and the cheek, extending to the lateral surface of the neck. The skin was distended and red. The submandibular lymph nodes were not palpable owing to edema of the overlying tissues. Great difficulty was experienced in opening the mouth. The oral temperature was 103.6 F. Intraorally, the tissues surrounding the tooth socket were inflamed and red, the swelling extending into the mucobuccal fold. A continuous trickle of blood from the socket had formed several blood clots in the socket itself and around the mouth.

The physical condition was essentially negative and not contributory to the chief complaint.

*Treatment.*—The mouth was irrigated with a physiologic solution of sodium chloride and freed of blood clots. Hemorrhage was controlled by means of cotton pellets saturated with tannic acid and adrenalin, introduced into the bleeding socket, and pressure applied on the pellets. The patient was then admitted to the hospital ward, and the following medication was ordered: sulfathiazole, 1 gm., immediately, followed by 0.5 gm. every four hours; sodium bicarbonate, 1 gm., immediately, followed by 0.5 gm. every four hours; infusion of 1,000 cc. of 5 per cent dextrose in distilled water, intravenously; vitamin K, 1 mg., intramuscularly, and a hemostatic, 2 cc., intramuscularly, every three hours for six doses each; liquid diet, with forced fluids to 2,500 cc. daily; hot wet magnesium sulfate compresses to the right side of the face and neck; alcohol rubs; icebags to forehead and axillary regions, and acetylsalicylic acid, 5 grains, every four hours. The temperature was taken by rectum.

*Laboratory Examination.*—The urine was alkaline, with specific gravity 1.010, and negative for albumin and sugar. The serologic findings were negative. Repeated blood cultures, July 10 and 12, were negative. Blood examination revealed: hemoglobin, 73 per cent; red cells, 3,800,000; white cells, 20,000; polymorphonuclears, 68 per cent; lymphocytes, 8 per cent; eosinophils, 2 per cent.

*Resident in oral surgery at Charity Hospital of Louisiana, and instructor in oral surgery, Loyola University.

*Diagnosis.*—The diagnosis was: acute postoperative submandibular cellulitis, with a possibility of acute septicemia.

*Course.*—July 10, at 8 p.m., the rectal temperature was 105 F. Sodium sulfathiazole, 2.5 gm., was added to the 1,000 cc. infusion of 5 per cent dextrose in distilled water.

July 11, at 8 a.m., the temperature had dropped to 101.4 F. The patient was able to take fluids. During the day, the temperature rose slowly, registering 104.9 F. at 8 p.m. The patient was considered to be dangerously ill and another infusion of 5 per cent dextrose in distilled water with 2.5 gm. of sodium sulfathiazole was given intravenously. The temperature rose steadily and at 11 p.m. registered 107 F. rectally. The patient was comatose. The white cell count was 23,500. Infusion was continued and 15,000 units of penicillin was given intramuscularly, followed by 10,000 units every three hours day and night.

July 12, at 8 a.m., the temperature was 100. Swelling of the face was still marked. The patient was able to take liquids by mouth. The sulfa drug was discontinued and penicillin continued. At 4 p.m., the temperature had risen to 104 F., but, from there on, it dropped slowly.

July 15, at 8 a.m., the temperature was 99. The swelling of the face and neck did not show fluctuation intra-orally or extra-orally. Resolution was gradual until the swelling had completely disappeared, thirteen days after admission to hospital. Tenderness in the region persisted for several weeks after the patient had been discharged.

### COMMENT

This is one of the many cases in which sulfonamide therapy had proved ineffective. The patient had received 7.5 gm. of sulfathiazole orally and intravenously before penicillin was administered, without any clinical improvement. From the time that penicillin therapy was instituted until the temperature was controlled, 240,000 units had been administered, intramuscularly. Pertinent in this case is the fact that no radical incisions were made for drainage. Indications for incisions are, of course, dependent on localization and fluctuation.

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## AMERICAN SOCIETY FOR ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

The profession is cordially invited to attend the Spring Meeting of the American Society for the Advancement of General Anesthesia in Dentistry at the Hotel New Yorker, Thirty-Fourth Street and Eighth Avenue, New York City, on Monday evening, March 25, at 8:15. A pre-meeting dinner will be held at the hotel at 7 o'clock.

The scientific program will be devoted to a discussion of the physiology of respiration with special relationship to anesthesia.—*M. Hillel Feldman, Executive Secretary.*

# Correspondence

## PRIMARY CLOSURE OF FACE AND JAW WOUNDS

*To the Editor:*

I read with great interest Major Converse's account of his work in Algiers with the French maxillofacial casualties from Tunisia and Italy. He writes that "Experience in North Africa and Italy corroborates previous reports of the inadvisability of primary suture of gunshot wounds of the face."

In Algiers, where we had the good fortune of seeing much of Major Converse's work, we were responsible for the treatment of all British maxillofacial casualties. Working in Algiers, it was quite impossible to do primary sutures on Tunisian battle casualties, which did not reach this base until five to eight days old. The early local bomb casualties and the local accidental wounds of the area were treated by us by primary suture, with results which clearly showed that the method was that of choice when the cases were seen early enough (within twenty-four to forty-eight hours).

In Italy, our unit had the treatment of the British maxillofacial casualties of the battles on the West Coast and Central Italy. From the Garigliano to the final break through at Bologna, cases were received within eight to twenty-four hours of wounding and a systematic policy of primary closure for facial wounds was adopted. This policy was in accordance with what we saw practiced by the plastic surgeons of the evacuation hospitals of the U. S. Army, notably Maj. S. G. Balkin, from whom we received much valuable help and advice.

The essential fact about primary closure as a treatment of missile wounds of the face and jaws is that it must be done well or it is better not done at all. The work is exacting, and must be done by a team of a surgeon, dentist and anesthetist, with the right equipment, well used to the work and to working together.

Under these conditions, a mortality of about 1 per cent can be expected (there were fifteen deaths in our first 1,000 jaw fractures). Jaw wounds treated by soft tissue excision, thorough removal of devitalized bone, watertight closure of the mouth and primary closure of the skin show a drop of 60 per cent in the incidence of bone sequestration and a mandibular union rate from two to four weeks quicker than that for similar wounds receiving otherwise thorough treatment, but left open. The incidence of antral infection in open maxillary wounds which were closed primarily was 1 to 2 per cent.

I believe that these figures are approximately the same as those of the plastic surgeons of the U. S. Army in Italy who practiced primary closure of facial wounds.

The value of the method is undoubted. It would be an enormous pity if this were not generally recognized and if, in any future theater of war, there were a return to the old policy of leaving a facial wound open at primary treatment; a policy which, in the first few years of the war, caused so much unnecessary sequestration, delay in union, deformity and suffering.

PATRICK CLARKSON, Major R.A.M.C.



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# Book Reviews

THE CLASSIFICATION AND TREATMENT OF INJURIES TO THE TEETH OF CHILDREN: A REFERENCE MANUAL FOR THE DENTAL STUDENT AND THE GENERAL PRACTITIONER. By Roy Gilmore Ellis, B.D.S. (Adel.), D.D.S., M.Sc. (Dent.), Professor of Operative Dentistry and Director of the Dental Clinic Faculty of Dentistry, University of Toronto. Price $2.75. Chicago: The Year Book Publishers, Inc., 1945.

"The Classification and Treatment of Injuries to the Teeth of Children" deals with fractured or traumatized anterior teeth. The book, of 200 pages, is well illustrated, with numerous fine photographs and line drawings. A complete bibliography follows each chapter.

In the first chapter, the author classifies the various types of injuries as a basis for treatment. Each of the following chapters is conveniently begun with an illustrated description of the classification dealt with, and a concise description of the treatment of the particular problem.

The second chapter deals with the treatment of simple fracture, with no dentin involved. Each succeeding chapter treats of the different degrees of fracture; i.e., how to deal with a fractured tooth involving only the dentin, one with an exposed vital pulp or one with a devitalized pulp.

Treatment of spaces created by loss of teeth as a result of trauma is discussed from the standpoint of stationary as well as removable prostheses. The replacements are designed according to the age at which the teeth were lost.

The last chapter deals with traumatic injuries to deciduous incisors in a rather short paragraph, in which the author prescribes treatment to meet the various problems involved. It is his opinion that the real problem involves treatment of fractured permanent incisors.

The book is well written and easy to read and to understand. It is a worth while contribution to dental literature. It should be in the library of every dentist who does not eliminate children from his practice.

JOSEPH T. COHEN

FACIAL PROSTHESIS. By Arthur H. Bulbulian, M.S., D.D.S., Director, Museum of Hygiene and Medicine, The Mayo Foundation, Rochester, Minn. 241 pages. 202 illustrations. $5. Philadelphia: W. B. Saunders Co., 1945.

Prosthetic restoration of the missing parts of the extremities has long been an accepted orthopedic procedure, but surgery knows little of the possibility of prosthetic restoration in deformities of the face and jaws. One reason for this lack of knowledge is the fact that this specialty has been developed by dentists, and dental literature and subject matter are almost exclusively in dental periodicals and books. Secondly, it being a highly specialized subject, few in the dental profession have taken the necessary training for meeting facial and maxillary problems.

Since World War I, prosthetic methods of reconstruction have received much attention. Knowledge gained from World War I was successfully used by new surgeons in deformities resulting from malignant diseases of the face and the jaws.



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This concise book on facial prosthesis undoubtedly will meet a great demand as, at the present time, there seems to be more interest in facial prosthesis than ever before. The author limits the subject purely to artificial restoration of the face, especially the ear, nose and orbit. The text does not cover maxillary restorations, which are often part of the treatment of such deformities.

As the author plainly states, the repair of facial deformities is primarily a surgical problem; but there are numerous conditions and circumstances which make surgical treatment impossible or inadvisable. In such cases, artificial restoration of the missing parts of the face of a temporary or permanent nature is welcome. The author has somewhat overemphasized the use of latex as a suitable material for restoration, and has not given enough importance to other materials such as acrylics.

The book is divided into fourteen chapters, and the classification of subjects is excellent. There are numerous diagrams and illustrations to help the reader in carrying out the technics of restoration. In summary, it is a good, small book to introduce prosthetic concepts and technics to the person interested in restorative problems of the face.

V. H. KAZANJIAN

FACIAL AND BODY PROSTHESIS. By Carl Dame Clarke, Associate Professor of Art as Applied to Medicine, School of Medicine, University of Maryland; Captain, Sanitary Corps, Army of the United States, Department of Moulage and Prosthetics, Army Medical Museum. 200 pages. 75 illustrations. $5. St. Louis: C. V. Mosby Co., 1945.

This is virtually a handbook concerning materials and methods used in the making of prostheses. The author obviously is familiar with the historical background and has kept himself abreast of modern developments in this field. His approach in this volume is more from the standpoint of a technician and artist than from that of a clinician, although, for the most part, his statements are medically sound.

Materials and technics are discussed in some detail with the exception of those which have been fully described before. These he refers to in an excellent bibliography. He describes, in greatest detail, the use of latex, but the passages on the use of wax, plaster of Paris and agar compositions are adequate. The discussion of the coloring and the application of prostheses is good.

The chapter on the use of resilient and elastic resins is too brief, and limitation of the discussion of hard prosthetic devices to a small space is unjustified. The chapter on the repair of cranial defects by cast chip-bone grafts is probably out of place in this volume since it applies to a limited field and one which has more to do with grafting of living substances than to the subject of prosthetics. One case is shown wherein a prosthetic nose and upper lip are used. This procedure is usually unwise, the upper lip never appearing to be normal. As an expedient before plastic surgery is finished, use of such a device may be justified.

One is justified in endorsing this book in spite of these relatively minor objections because of the clarity with which it is written, the excellent discussion of materials and methods and an absence of superfluous words. It certainly should be most useful to reconstructive surgeons, medical artists and dentists.

V. H. KAZANJIAN

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